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MECHANICS

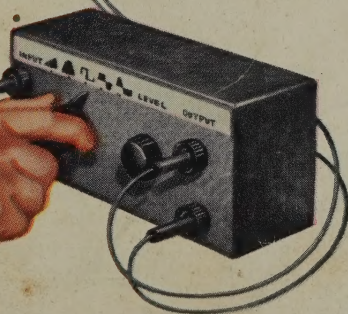
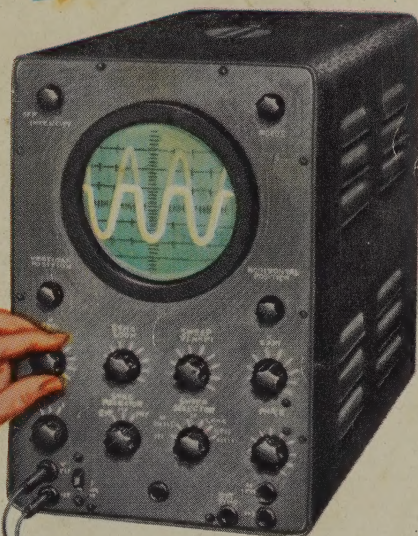
Complete 2-Meter Ham Station

RADIO-TV EXPERIMENTER

No. 569
75c

FALL
1960

37 Electronic
Projects



- TRANSISTOR ANALYZER
- FREQ STANDARD
- 2-TUBE LW RCVR
- TUNNEL DIODE OSC
- VAN de GRAAFF GEN
- MUSIC-ANNUNCIATOR
- WIRELESS INTERCOM
- AC POWER PANEL
- DRY BATTERY TESTER-CHARGER
- MINIATURE TAPE RECORDER
- TYPACODE

PLUS—

WHITE'S
RADIO
LOG



AM-FM-TV DIRECTORY
WORLD-WIDE SHORT WAVE

plans for this
WAVEFORMER, p. 43

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RADIO-TV EXPERIMENTER

Fall 1960 Edition

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Cover by Harold R. Stluka

B. G. DAVIS
Publisher

JOEL DAVIS
Assistant Publisher

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450 East Ohio Street

Chicago 11, Illinois

The Radio-TV Experimenter contains a selected few of the most popular electronics projects and radio and TV maintenance articles that have appeared in *Science and Mechanics Magazine*, plus a number of projects and helpful articles on the same subjects appearing for the first time.

Science and Mechanics Handbook Annual No. 6, 1960—No. 569

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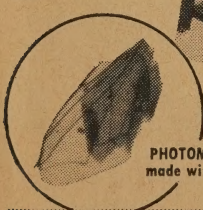
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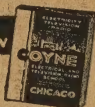
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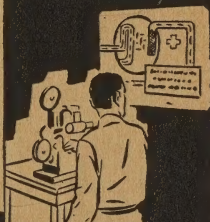
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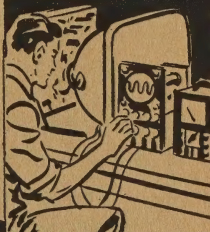
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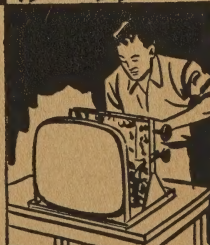
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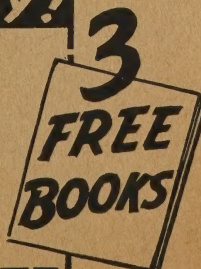
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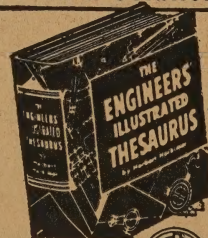
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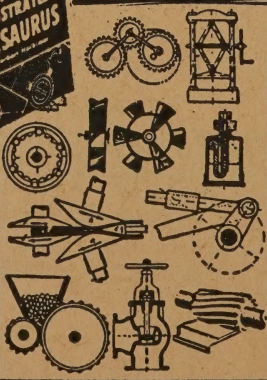
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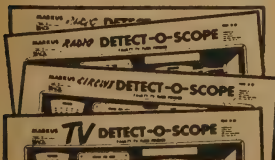
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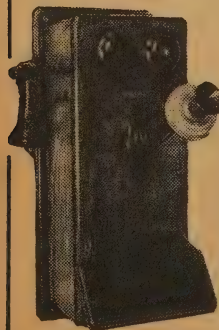
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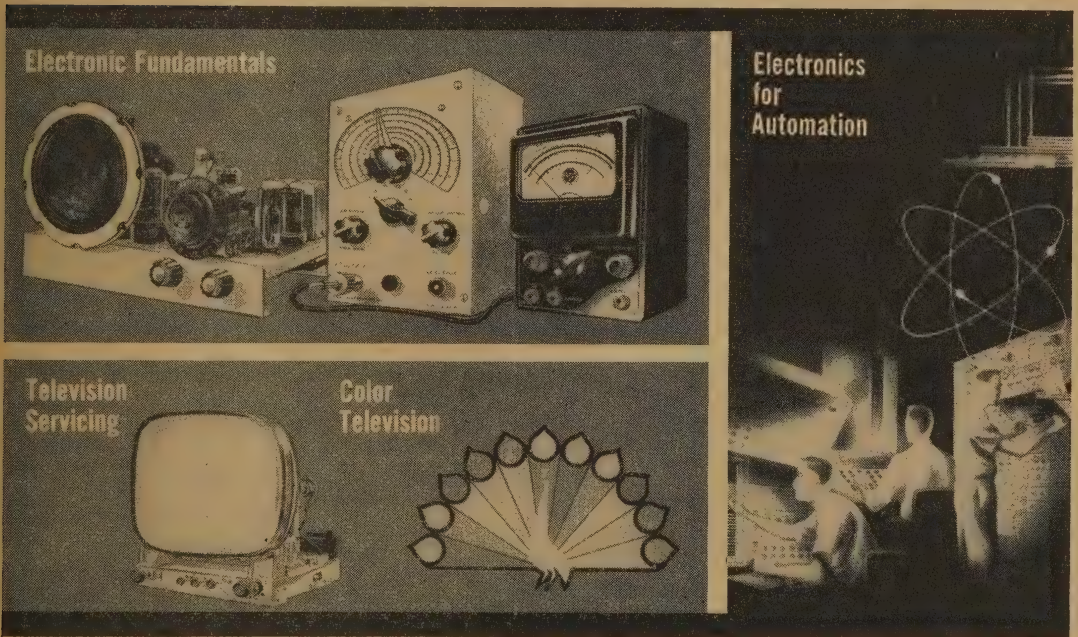




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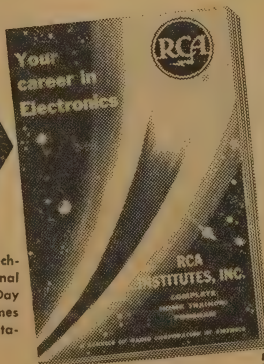
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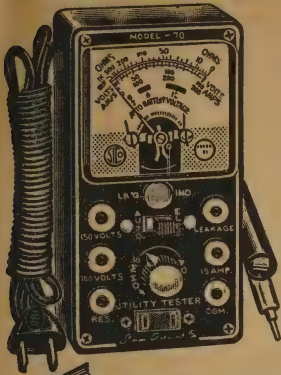
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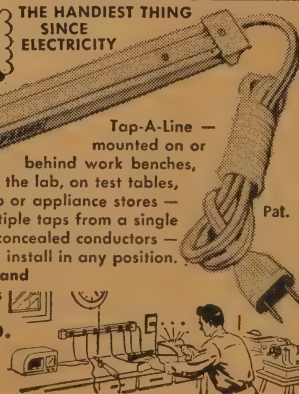
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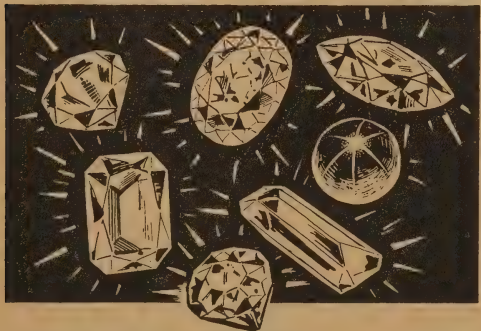
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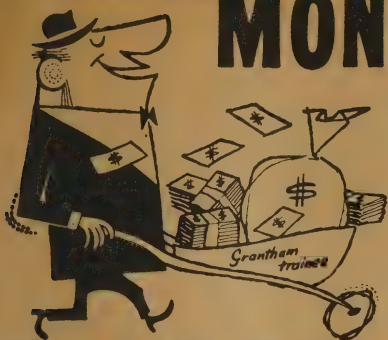
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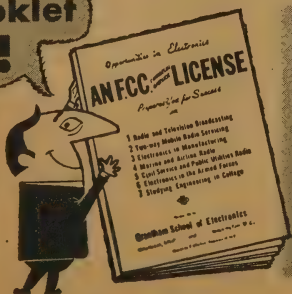
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How to Find a Buyer for Your Invention

LISTS HUNDREDS OF NEEDED INVENTIONS

A manufacturer in Chicago is eager to pay good money for new plastic toys or houseware inventions with wide appeal.

A large company in St. Louis assures big cash rewards for ideas or inventions relating to paint specialties. A Boston company pays inventors 5% of gross sales for new ideas for gadgets and inventions for the home, automobile, or garden. An electronics firm will pay big money for new accessories to improve TV reception.

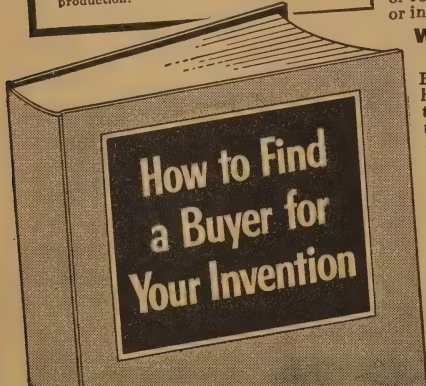
These are just a few of the hundreds of needed inventions listed by 140 top manufacturers. Each manufacturer lists the exact type of invention he is interested in buying, and company executive to write to for immediate action. **FOUR** complete cross-indexed lists give you this valuable information to guide you:

Cross Index "A"
—lists hundreds of needed inventions and types of products for which improvements are wanted.

Cross Index "B"
—gives listing of materials each manufacturer uses in current production.

Cross Index "C"
—enables you to locate the manufacturer with the type of equipment needed for producing your idea.

Cross Index "D"
—lists facilities for developing, producing, and marketing your inventions.



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HOW to Determine if Your Idea or Invention is Salable: Saves you time, money, and heartbreak by telling you **BEFOREHAND** how to find out whether your big idea is marketable, 7 questions and answers tell you whether someone will pay good money for your idea.

WHERE to Sell Your Invention: Complete, up-to-the-minute list of 140 big manufacturers **actively** interested in buying inventions. Details their specific needs; facilities available; name and address of official to contact.

EIGHT Different Ways to Sell an Invention. Tells you step-by-step how to sell your idea or invention

direct to a manufacturer; through a patent broker; classified ads; publicity and news releases; at exhibitions sponsored by engineering societies, etc.

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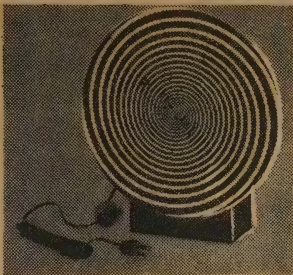
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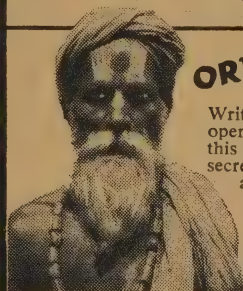
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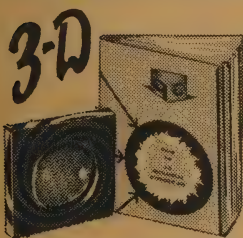
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☐ CX-4 @ \$1.95, ☐ CX-5 @ \$1.95, ☐ CX-7 @ \$4.00,
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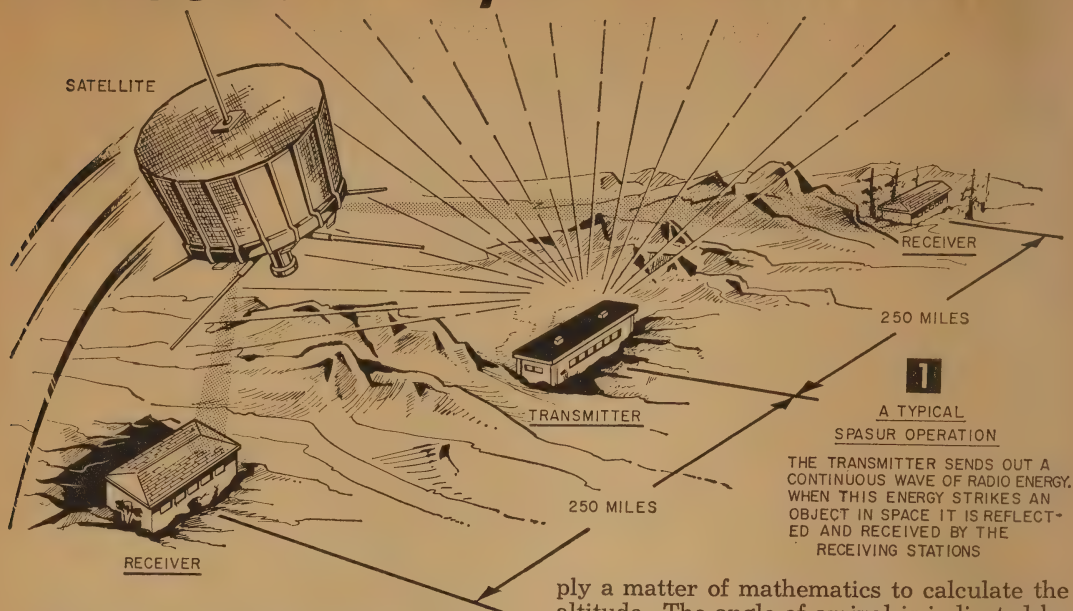
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SPASUR: New Eye On The Universe



JANUARY 1960. A dark satellite circles the Earth, its origin unknown. The space vehicle, transmitting no signal—at least no signal audible in the Western world—should have remained undetected, but didn't. Why not? The reason is SPASUR, a new electronic device built by Bendix Radio for the United States government.

Such an important new system should involve some sweeping new discovery—but that doesn't happen to be the case. SPASUR makes use of two very well known principles of radio reception, proving again that what man does with his discoveries is even more important than the discoveries themselves.

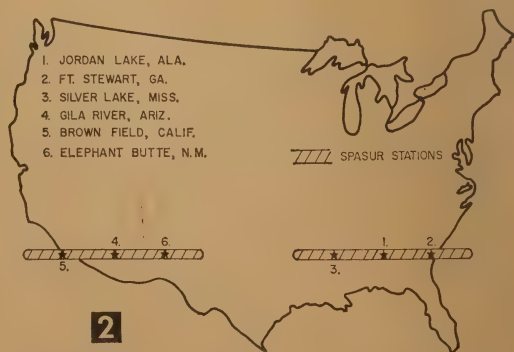
First part of the SPASUR system consists of a VHF transmitter fed into a non-directional antenna. VHF signals are not normally reflected back to Earth unless they happen to strike a solid object. This is precisely what happens when the SPASUR (SPaCe SURveillance) transmission strikes an object in space. Once the reflected signal is picked up by a properly equipped receiving station, position and altitude are determined.

Each SPASUR chain consists of a transmitter and two receiving locations, 250 miles either side of the transmitter. Thus the chain is spread out along a 500 mile strip (see Fig. 2). There are presently a pair of chains operating, centered on Jordan Lake, Alabama, and Gila River, Arizona. A satellite orbiting the Earth must eventually pass within range of at least one of these chains.

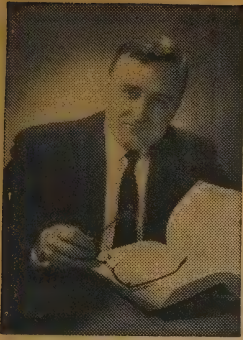
At a receiving station, the bearing is first taken and then the angle between signal and Earth is measured. From the latter, it is sim-

ply a matter of mathematics to calculate the altitude. The angle of arrival is indicated by the phase difference between two parallel antennas. Again this method is nothing new, it's been used for many years in short-wave research. However, when applied to SPASUR it is much more accurate since signals arrive via only one path while on short-wave multipath reception is common.

The received data is fed into a computer and after three sightings both course and speed are revealed. Working with MINITRACK, another Bendix system which keeps tabs on broadcasting satellites, SPASUR provides a complete picture of "nearby" (near Earth) space activities.—C. M. STANBURY II



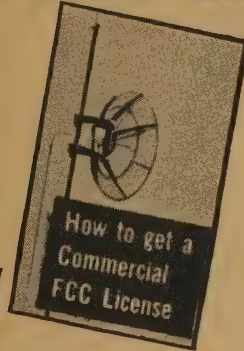
The approximate positions of the six stations of the U. S. Navy Space Surveillance detection net. The stations are divided into two complexes (eastern and western), each consisting of a transmitting station and two receiver stations. The stations are located along a great circle track between Fort Stewart, Georgia, and the Naval Air Station, Brown Field, just south of San Diego, California.



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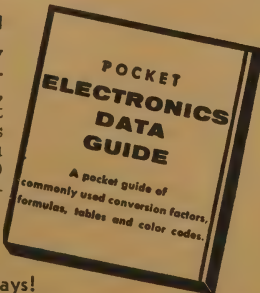
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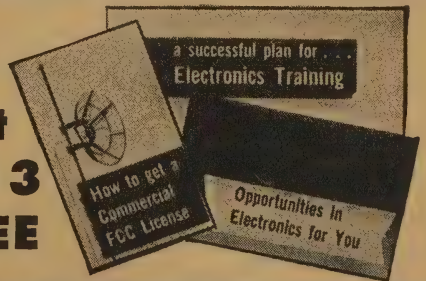
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Memorandum, 1915

Subject: Radio Music Box

David Sarnoff

IN 1915, David Sarnoff was Assistant Traffic Manager of the Marconi Wireless Telegraph Company of America. In September of that year he sent to the Vice President and General Manager of the company the following memorandum:

"I have in mind a plan of development which would make radio a 'household utility' in the same sense as the piano or phonograph. The idea is to bring music into the house by wireless.

"While this has been tried in the past by wires, it has been a failure because wires do not lend themselves to this scheme. With radio, however, it would seem to be entirely feasible. For example—a radio telephone transmitter having a range of, say, 25 to 50 miles can be installed at a fixed point where instrumental or vocal music or both are produced. The problem of transmitting music has already been solved in principle and therefore all the receivers attuned to the transmitting wave length should be capable of receiving such music. The receiver can be designed in the form of a simple 'Radio Music Box' and arranged for several different wave lengths, which should be changeable with the throwing of a single switch or pressing of a single button.

"The 'Radio Music Box' can be supplied with amplifying tubes and a loud speaking telephone, all of which can be neatly mounted in one box. The box can be placed on a table in the parlor or living room, the switch set

accordingly and the transmitted music received. There should be no difficulty in receiving music perfectly when transmitted within a radius of 25 to 50 miles. Within such a radius there reside hundreds of thousands of families . . .

"The manufacture of the 'Radio Music Box' including antenna, in large quantities, would make possible their sale at a moderate figure of perhaps \$75.00 per outfit. The main revenue to be derived will be from the sale of 'Radio Music Boxes' . . ."

Hindsight tells us Marconi Wireless should have seized opportunity by the antenna. Instead, they ignored the memo. Five years later, after the Radio Corporation of America was organized, Sarnoff pulled his copy of the memo out of his files and revived his recommendation of 1915 in a report to Owen D. Young, Chairman of the Board of the new company.

Four weeks later, on March 3, 1920, Sarnoff was asked for an estimate of prospective radio business. He replied:

"The 'Radio Music Box' proposition . . . requires considerable experimentation and development; but, having given the matter much thought, I feel confident in expressing the opinion that the problems involved can be met. With reasonable speed in design and development, a commercial product can be placed on the market within a year or so.

"Should this plan materialize it would seem reasonable to expect sales of one million (1,000,000) 'Radio Music Boxes' within a period of three years. Roughly estimating, the selling price at \$75 per set, \$75,000,000 can be expected. This may be divided approximately as follows:

First Year	
100,000 Radio Music Boxes....	\$ 7,500,000
Second Year	
300,000 Radio Music Boxes....	22,500,000
Third Year	
600,000 Radio Music Boxes....	45,000,000

RCA's actual sales of "Radio Music Boxes" during the first three years of its activities in this field, were:

1st year.....1922.....	\$11,000,000
2nd year.....1923.....	22,500,000
3rd year.....1924.....	50,000,000

Total.....	\$83,500,000
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Broadcasting had been born.



The serious young junior executive above is David Sarnoff as he looked 40 years ago; today he is RCA's Chairman of the Board of Directors and Chief Executive Officer.



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—	1AX2	.62	—	4CS6	.61	—	6AW8	.89	—	6DG6	.59	—	12AF3	.73	—	12CU5	.58
—	1B3GT	.79	—	4DE6	.62	—	6AX4	.65	—	6DQ6	1.10	—	12AF6	.49	—	12CU6	1.06
—	1DN5	.55	—	4DK6	.60	—	6AX7	.64	—	6DT5	.66	—	12AJ6	.46	—	12CX6	.54
—	1G3	.73	—	4DT6	.55	—	6BA6	.49	—	6DT6	.53	—	12AL5	.45	—	12DB5	.69
—	1J3	.73	—	5AM8	.79	—	6BC5	.54	—	6EU8	.79	—	12AL8	.95	—	12DE8	.75
—	1K3	.73	—	5AN8	.86	—	6BC7	.94	—	6EA8	.79	—	12AQ5	.52	—	12DL8	.85
—	1L6	1.05	—	5AQ5	.52	—	6BC8	.97	—	6H6GT	.58	—	12AT6	.43	—	12DM7	.67
—	1LN5	.59	—	5AT8	.80	—	6BD6	.58	—	6J5GT	.51	—	12AT7	.76	—	12DR6	1.04
—	1R5	.62	—	5BK7A	.82	—	6BE6	.55	—	6J6	.67	—	12AU6	.50	—	12DS7	.79
—	1S5	.51	—	5BQ7	.97	—	6BF6	.44	—	6K6	.63	—	12AU7	.60	—	12DZ6	.56
—	1T4	.58	—	5BR8	.79	—	6BG6	1.66	—	6S4	.48	—	12AV5	.97	—	12EL6	.50
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—	3BC5	.54	—	5V6	.56	—	6BQ6GT	1.05	—	6W4	.57	—	12BE6	.53	—	12SN7	.67
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—	3BY6	.55	—	6AC7	.96	—	6BY6	.54	—	6X8	.77	—	12BQ6	1.06	—	12W6	.69
—	3BZ6	.55	—	6AF3	.73	—	6BZ6	.54	—	7AU7	.61	—	12BY7	.74	—	12X4	.38
—	3CB6	.54	—	6AF4	.97	—	6BZ7	.97	—	7A8	.68	—	12BZ7	.75	—	17AX4	.67
—	3CF6	.60	—	6AG5	.65	—	6C4	.43	—	7B6	.69	—	12C5	.56	—	17BQ6	1.09
—	3CS6	.52	—	6AH6	.99	—	6CB6	.54	—	7Y4	.69	—	12CA5	.59	—	17C5	.58
—	3CY5	.71	—	6AK5	.95	—	6CD6	1.42	—	8AU8	.83	—	12CN5	.56	—	17CA5	.62
—	3DK6	.60	—	6AL5	.47	—	6CF6	.64	—	8AW8	.93	—			—		
—	3DT6	.50	—	6AM8	.78	—	6CG7	.60	—	8BQ5	.60	—			—		
—	3Q5	.80	—	6AN4	.95	—	6CG8	.77	—	8CG7	.62	—			—		
—	3S4	.61	—	6AN8	.85	—	6CM7	.66	—	8CM7	.68	—			—		
—	3V4	.58	—	6AQ5	.50	—	6CN7	.65	—	8CN7	.97	—			—		
—	4BC5	.56	—	6AR5	.55	—	6CR6	.51	—	8CX8	.93	—			—		
—	4BC8	.96	—	6AS5	.60	—	6CS6	.57	—	8EB8	.94	—			—		
—	4BN6	.75	—	6AT6	.43	—	6CU5	.58	—	10DA7	.71	—			—		
—	4BQ7	.96	—	6AT8	.79	—	6CU6	1.08	—	11CY7	.75	—			—		
—	4BS8	.98	—	6AU4	.82	—	6CY5	.70	—	12A4	.60	—			—		
—	4BU8	.71	—	6AU6	.50	—	6CY7	.71	—	12AB5	.55	—			—		
—	4BZ6	.58	—	6AU7	.61	—	6DA4	.68	—	12AC6	.49	—			—		
—			—	6AU8	.87	—	6DB5	.69	—	12AD6	.57	—			—		

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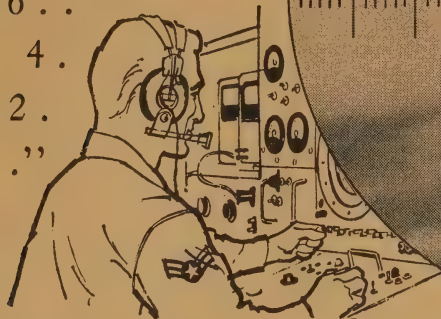
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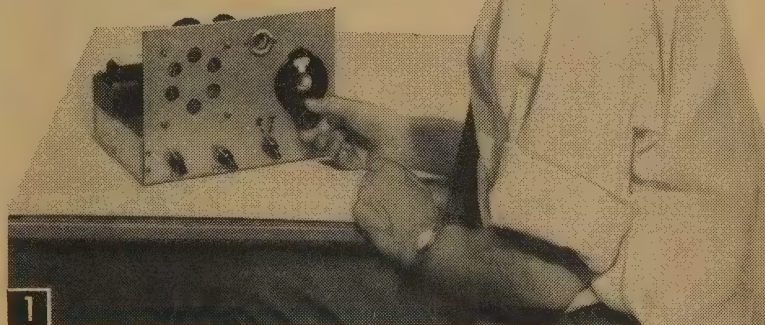
TWO-METER

Amateur Station

Compact and easy to build, this two-meter station uses standard parts and tubes throughout, provides both voice and modulated code communication and may be used for portable operation

You can build this transceiver for less than half of what any similar, presently available commercial rig sells for.

by C. F. ROCKEY,
W9SCH/W9EDC



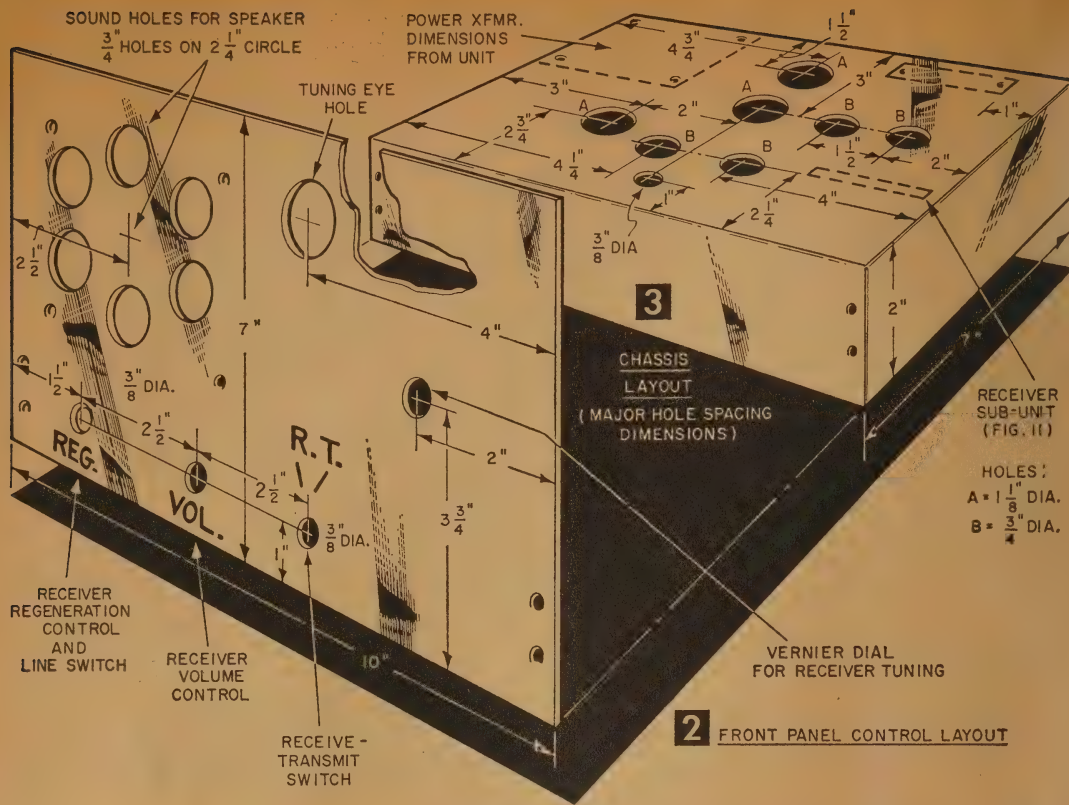
OPEN to holders of all classes of amateur license, the 144-megacycle, two-meter amateur band offers interesting possibilities to the experimentally inclined ham. This little rig provides an excellent starting setup, or a nice little extra rig.

Begin construction by drilling and punching the major holes in the front panel and chassis (Figs. 2 and 3). Mount the panel temporarily upon the chassis while drilling the holes for the two potentiometers and the Receive-Transmit switch. With all major holes drilled, mount the power transformer, then the rectifier tube socket and the Jones barrier terminal strip. Temporarily mount the regeneration control potentiometer upon the panel; it includes the On-Off power-line switch, which is wired-in immediately.

Now complete the power supply wiring (see Fig. 7) first connecting the transformer leads to the rectifier tube socket, then wiring in the 120-v primary leads. The electrolytic capacitors are held in place by their mounting brackets, as are the positive "hot" leads which are supported by a two-lug, insulated tie-point strip. Last of all, install and connect the filter choke. Ground one side of the 6.3-v heater winding and bring the other end out to one of the unused rectifier socket lugs, which will serve as a tie-point for connection to the heater of each of the tubes (except the rectifier, of course).

After you've wired and carefully checked the power supply, measure the resistance between the positive high-voltage terminal and ground. There should be more than 10,000 ohms. Less indicates a wrong connection, or short. When the high-voltage circuit has been checked out, connect the line cord to its terminals on the terminal strip and insert the rectifier tube in its socket. When the switch is turned on, the rectifier tube filaments should glow dull red and a dc voltage of at least 250 v (more won't hurt) should be observed from the positive terminal of the last filter capacitor to ground.

Audio Section. When the power supply is operational, remove the rectifier tube and line cord and fasten in the sockets for the audio frequency section, including the 12AT7, half of which is used for an AF amplifier. (The other half is the crystal oscillator, which is wired-in later.) The AF section includes one and one-half 12AT7's, and the 6V6GT. The 12AT7 sockets are mounted with 4-36 x 1/4-in. rh machine-screws and nuts. Be sure to put a soldering-lug under one of the mounting screws for each socket to provide a ground point for that part of the circuit. Pin No. 9 on each 12AT7 socket, and pin No. 7 on the 6V6GT are connected to the 6.3-v heater winding (ungrounded green lead) of the power transformer. Ground pins 4 and 5 on each 12AT7 socket, as well as the metal tube



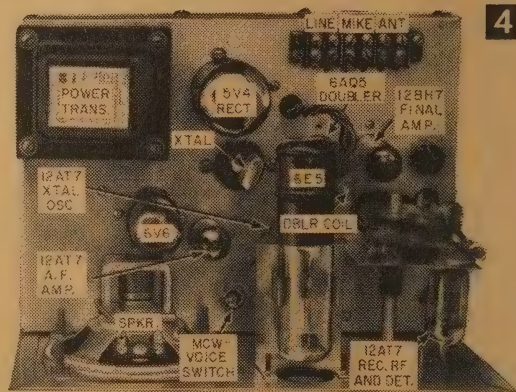
in the center. On the 6V6 socket, ground pins 1 and 2.

Work backwards from the output transformer through the 6V6 (see Fig. 6). Ground the "common" terminal on the output transformer secondary; leave the other secondary terminal alone for the moment. The output transformer is mounted with 6-32 *rh* machine screws and nuts. When the 6V6 has been wired, temporarily connect the loudspeaker (between unused secondary lead and ground), insert the 6V6 and rectifier tube, plug in line cord and turn on power. Both tubes should light and, when warm, a screwdriver touched to pin No. 5 (control grid) of the 6V6 should produce a characteristic clicky buzz in loudspeaker.

With the audio output stage connected and operating, unhook external connections, remove tubes, and wire the 12AT7 stage that feeds the signal to the 6V6. Use 2- and 4-point insulated tie-lugs as needed to hold small parts firmly in place by their leads.

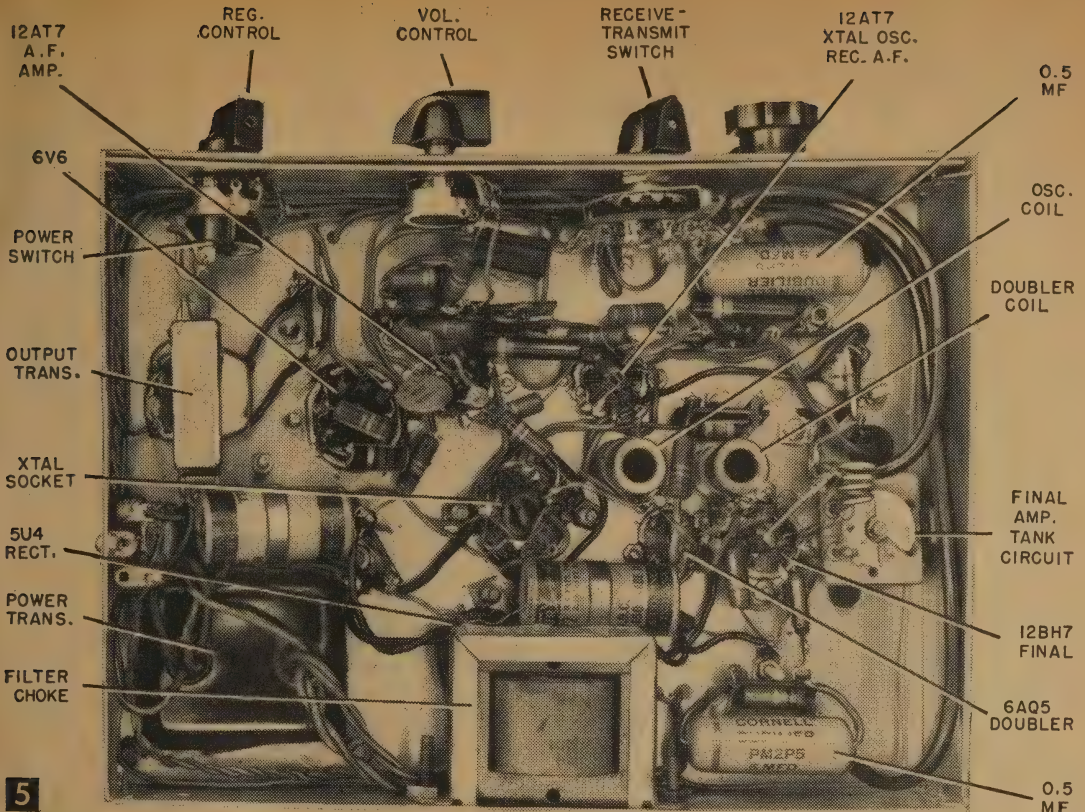
After you've wired and checked this next stage, put in tubes, re-connect speaker and plug in line. When all tubes are warm, carefully touch a screwdriver to the control grid terminal (pin No. 7) of the 12AT7. A much louder clicky buzz should be heard.

To complete further AF circuit wiring, you'll have to temporarily install both the



Receive-Transmit switch and the volume control potentiometer. Figure 8 shows connections for the non-shorting type R-T switch. Continue wiring by completing the 12AT7 amplifier stage that serves the receiver (see Fig. 9). Make all ground leads short.

To test this stage, set up as previously described, throw the R-T switch to "Receive," and check for the characteristic buzz at the grid. Advance the volume control, of course. Because of the relatively high amplification involved here, it should be possible to hear a faint hiss of tube noise when the volume control is fully advanced.

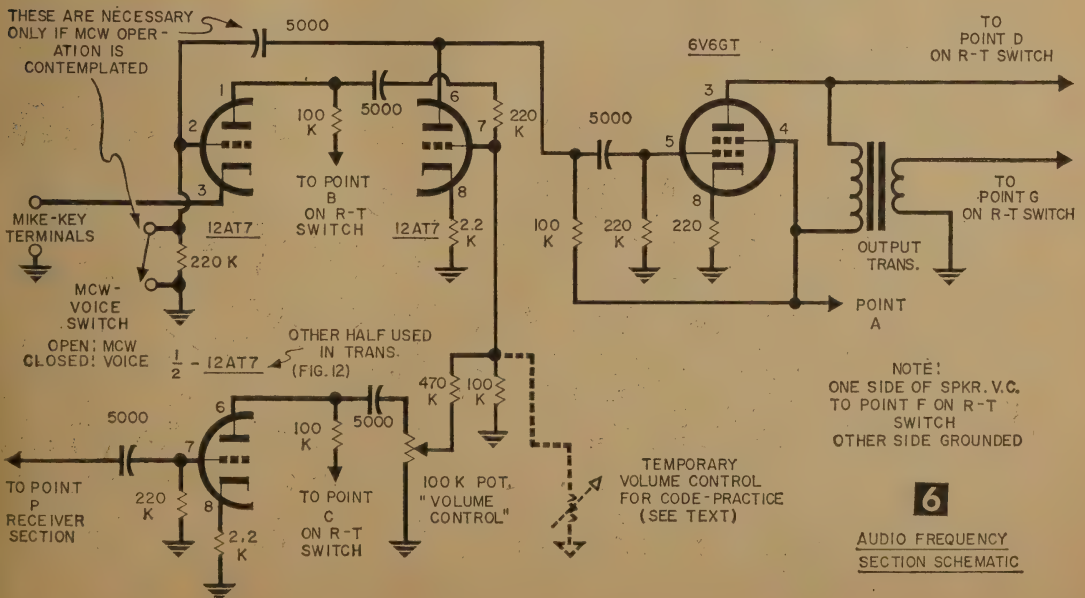


5

Finish the AF section by wiring the 12AT7, "speech-amplifier" stage. This circuit contains the SPST toggle switch that converts it into an oscillating multivibrator for modulated CW work. When the switch is open the circuit acts as a multivibrator, or tone

generator. When closed, the stage becomes a grounded-grid amplifier for the mike.

Connect external connections, as previously described for testing, and insert all tubes involved. Connect a 220K resistor temporarily across the Mike-Key terminals on the termi-

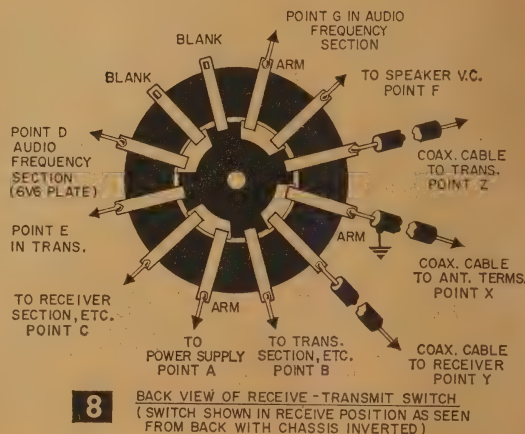
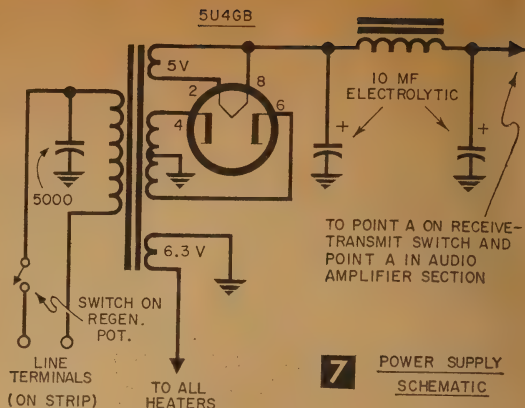


nal strip. When the toggle switch is in the open position, a loud, clean musical tone should emerge from the speaker. (Note that the volume control, since it is associated with the receiver only, does not affect the strength of the tone.)

Throw the toggle switch into the closed position and connect a single-button carbon microphone (Type "F-1," from Telephone Engineering Company, Simpson, Penn., or other similar single-button carbon mike) to the microphone terminals. Now, the system should

MATERIALS LIST—2-METER STATION

No. Req'd	Description
1	2 x 7 x 10" aluminum chassis
1	7 x 10" aluminum panel
3	knobs for 1/4" shaft
1	National type BM dial
1	tuning eye assembly for 6E5 tube (includes bracket, socket and bezel)
1	PM loudspeaker, 4" size Jensen
1	2 3/4 x 3 1/2" aluminum sheet, for detector (see text)
3	octal plastic tube sockets, Amphenol
4	9-pin miniature sockets, high frequency plastic insulation, Amphenol
1	7-pin miniature socket, Amphenol
1	6-terminal Cinch-Jones barrier terminal strip
1	SPST toggle switch, H&H
1	100K linear-taper potentiometer & switch (Mallory)
1	500K audio-taper potentiometer (Mallory)
1	power transformer, Chicago-Standard Type PM-8408
1	filter choke, Chicago-Standard, Type C-1708
1	output transformer, Chicago-Standard, Type A-3823
2	10 mfd. electrolytic filter capacitors, 450 working volt, Mallory
2	0.5 mfd. paper capacitors, 200 working volt, Cornell Dubilier
3	Ohmite type Z-144, 2-meter RF chokes
3	National type XR-50 coil forms, with iron slugs
1	four-pole, double-throw, non-shorting wafer switch, Centralab No. 1409
1	15 mmf variable tuning capacitor, Hammarlund HF-15
1	15 mmf BUD variable tuning capacitor type MC-1850, with one plate removed (see text)
1	47 ohm, one-watt carbon resistor
8	100K one-watt carbon resistors
2	47K, one-watt carbon resistors
2	22K, one-watt carbon resistors
4	2.2K, one-watt carbon resistors
5	220K, one-watt carbon resistors (includes one extra for new operation)
1	220 ohm, one-watt carbon resistor
1	470K, one-watt carbon resistor
1	1K, one-watt carbon resistor
1	1 meg., one-watt carbon resistor
5	50 mmf, 600 W.V. disk-type ceramic capacitors
8	5000 mmf, 600 W.V. disk-type ceramic capacitors
2	5 mmf, 600 W.V. disk-type ceramic capacitors
3	1000 mmf, 600 W.V. disk-type ceramic capacitors
1	brass shaft coupling 1/4" to 1/8" shaft (female to female)
1	type 48, 2-volt, 60 ma dial lamp bulb (for tuning)
1	1N34 crystal diode, Sylvania
1	"overtone" crystal approximately 36 megacycles, Texas Crystal Co., River Grove, Ill.
1	If you are a General class operator, you may select a crystal anywhere between 36 to 36.975 megacycles. Novices and Technicians must select one between 36.25 and 36.75 Ma. If you wish a certain frequency within the 144-megacycle band, divide that frequency by four to get your crystal frequency. Ask for the adapters to adapt the pin diameter to fit octal sockets pins. Texas Crystal Co. will supply these gratis when requested in order.
1	line cord and plug
1	plastic rod 1/4" dia., 3" long
1	5U4GB vacuum tube
1	6V6GT vacuum tube
3	12AT7 vacuum tube
1	6AQ5 vacuum tube
1	12BH 7 vacuum tube
1	6E5 vacuum tube
1	microphone, carbon, type F-1 (Telephone Engineering Co., Simpson, Penna.)
1	telegraph key (optional) Johnson Model 114-100
1	directional antenna for 144-Mc. amateur band, (the 5 element "Hi-Gain," or similar type is recommended.) With Co-axial transmission line and rotator
1	wire, rosin-core solder, screws, nuts, tie-points, etc.



behave exactly like a good, low-power public-address amplifier. (Do not use a crystal or a dynamic mike.) Make sure the switch is in "transmit" position, before making these latter tests.

The unit as so-far constructed will serve very well as a code-practice oscillator with the toggle switch open, or as a small PA amplifier, with the switch closed. If it's too loud for you, connect a 50,000-ohm variable resistor from the grid of the last 12AT7 to ground (see Fig. 6). Varying this control will vary volume, but it may also have some effect upon the tone of the oscillation.

To use the audio system so-far constructed for a code practice oscillator, connect an ordinary telegraph key, in series with a 220K, one-watt carbon resistor to the Mike-Key terminals. The frame of the key should be connected directly to the grounded side, the 220K resistor in series with the other side. At full output, the signal is strong enough to serve a roomful of students; the volume may be reduced by the temporary volume control described above. Be sure the toggle switch is in the open position, and the R-T switch in the Transmit position, of course.

Receiver Section. Start by connecting the

When the receiver super-regenerates properly, check the tuning range with a grid-dip meter. My receiver covers from about 140 to about 150 megacycles, with the 144-148 megacycle amateur band falling between about 60% and 70% of maximum capacitance of the tuning capacitor. The exact tuning range is not critical as long as the 144-148 megacycle amateur band is conveniently included.



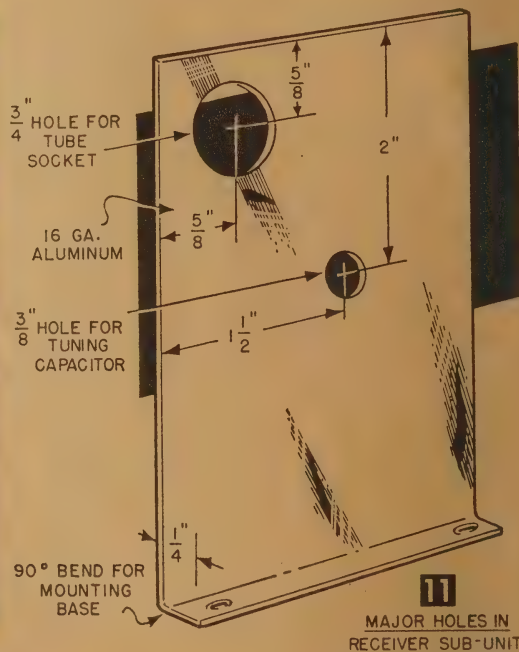
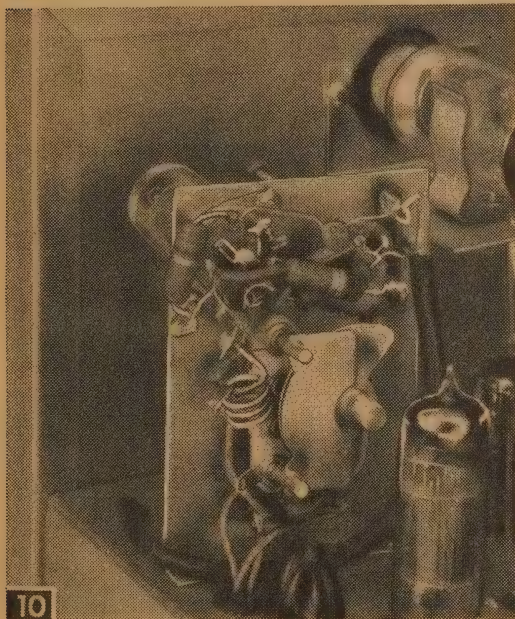
Transmitter. Start wiring with the crystal oscillator and work forward (see Fig. 11). The crystal plugs into any two *alternate* pins of the octal crystal socket; other unused pins may be used for tie-points for other circuits if desired. The crystal oscillator tube is the half of the 12AT7 that was *not* used for the AF amplifier circuit. The only critical part of the circuit is the coil, and this will cause no trouble if it is wound exactly as described in Fig. 13B.

After carefully checking the crystal oscillator circuit, proceed to the 6AQ5 frequency doubler stage. Again, this stage is straight-forward; only the coil being critical. Wind this coil exactly as shown in Fig. 13C, being careful to get the tap in the exact center. Ground the cathode and the screen bypass capacitor to the same point on the chassis, as close to the socket as possible. The 1K resistor should be fastened to a two-point insulated tie lug mounted close by the coil.

When this doubler stage is complete, wire the final amplifier stage. Although a frequency doubler, this circuit develops practically the same efficiency as a straight-through amplifier while at the same time avoiding the self-oscillation troubles which plague the lat-

stages is completed, insert tubes. Do not apply power yet, however. Instead, get your grid-dip meter, and carefully adjust each of the coils as closely as possible to its correct resonant frequency; 36 megacycles for the crystal oscillator, 72 megacycles for the doubler, and set the final tank to resonance at 144 megacycles. Be sure the tubes are in their proper sockets for this operation; their capacitance plays a big part in determining the resonant frequencies. If properly wound and installed, each of the coils should resonate at the correct frequency, with considerable extra slug-adjustment range available in either direction. The final tank coil may be adjusted by squeezing or spreading its turns.

When all coils have been pre-tuned, plug



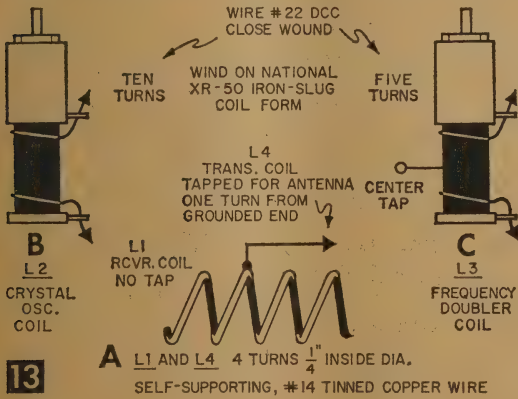
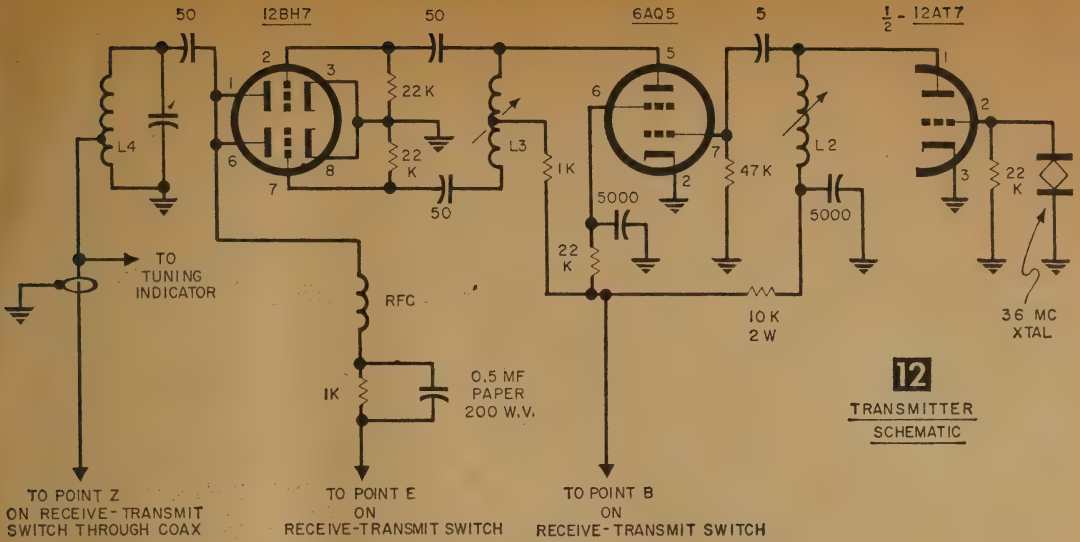
ter. Its push-push feature also helps to eliminate odd harmonics which could get into TV receivers and cause interference. The ordinary distortion-type frequency doubler, often used in simple VHF transmitter arrangements, provides none of this added spurious-harmonic suppression.

Again, since the output circuit is tuned to 144 megacycles, you *must* keep all leads as short and direct as possible. An extra quarter-inch of wire here can spell the difference between success and failure. Wind coil L4 exactly as shown in Fig. 13A and keep the leads short! Wire the entire final amplifier circuit carefully, but do not connect the antenna coax cable yet or the plus high-voltage lead. In the final stage, return all ground connections to the same point near the tube socket.

When the wiring of the transmitter RF

in the crystal, and apply power. Tune the grid dipper to 36 megacycles and immediately adjust the crystal oscillator coil for maximum oscillator output. If the crystal oscillator doesn't oscillate, recheck the wiring, and try another tube. When you find oscillation, screw the slug down until you get maximum output, then screw the slug *out* about three turns in the interest of stability and reliability of oscillation. Then immediately adjust the doubler coil slug for maximum output. Take a No. 48, or No. 49 dial light bulb (pink head) and solder a small loop of wire between its terminals. Then couple this loop closely about the doubler coil. If the doubler is operating properly, the lamp will light noticeably.

Now connect the positive high-voltage lead



to the final amplifier, apply power, and tune the final tank capacitor to maximum 144-megacycle output with the grid-dip meter. If you find plenty with the grid-dip meter, couple your "soup-loop" tuning lamp to the final coil and slightly re-tune. The bulb should glow brightly if the lamp is closely coupled. If you get weak, or no output, check the wiring again, or try another 12BH7 tube.

Now temporarily shut off power and plug-in the audio amplifier tubes. Connect your carbon mike to the *Mike-Key* terminals. Set the toggle switch to the closed position. Re-apply power and speak clearly into the mike. The bulb around the final amplifier tank should flicker markedly in step with your voice, indicating proper modulation.

The Finishing Touches. Pull out all tubes and remove all external connections. Mount the loudspeaker, the tuning-eye assembly, and the vernier dial upon the panel. Now remove the potentiometer and Receive-Transmit switch binding nuts and install the panel with the binding nuts and with self-tapping metal screws. Place knobs on potenti-

The VHF Amateur Bands

Today the VHF bands provide the greatest opportunity and challenge to the experimentally minded ham. These frequencies above 144 megacycles seem to be the only ones left wherein simple, low-powered equipment still can compete effectively against expensive, "store-bought" gear.

Nobody knows for sure the exact distance limitations on VHF communication. The first signal bounced off the moon by the U. S. Army back in 1946 was in the VHF range. On the other hand, it is the consistent, interference-free, short-haul communication, up to 50 miles or so, that is the operating bread-and-butter of the VHF amateur. Occasional long-distance spurts are to be considered as interesting diversions, rather than daily fare. Distance chasing, in itself, is not the whole of amateur radio. You'll have a lot of fun, face some stimulating problems, and meet some nice people on the two-meter band, believe me.

Those frequencies between 145 and 147 megacycles are available to both **novice** and **technician** class licenses, as well as the general-class operator. But do make sure that you have a license before you do any transmitting. "Citizens Band" license is **not** sufficient. You must have an **Amateur** license. (Write to the Federal Communications Commission office in the large city nearest you for details.)

In addition to the license, and to the usual hand tools owned by all radio experimenters, you should have available:

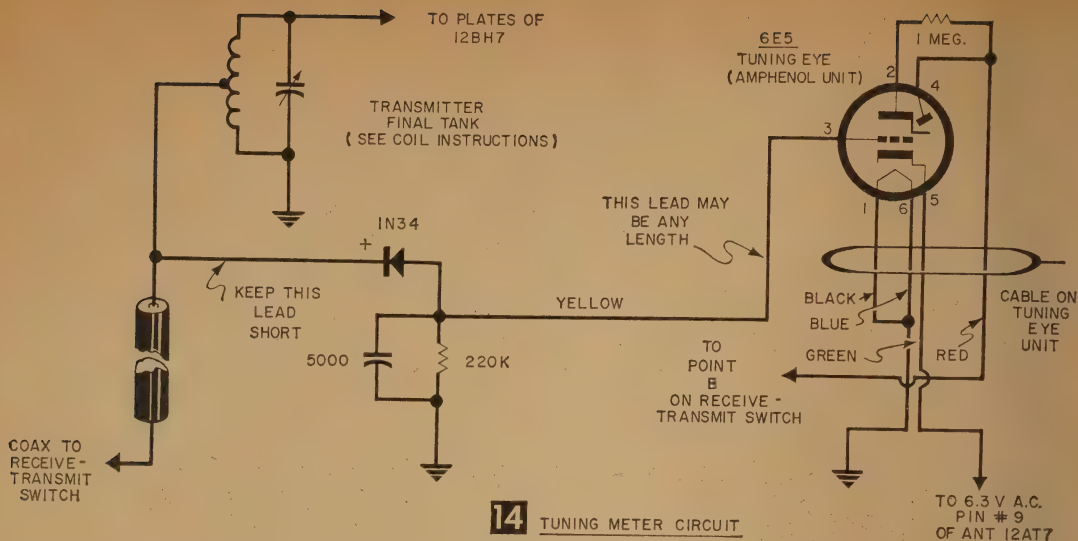
- 1) A good "two-meter beam," a directional antenna for the 144-megacycle band. Such an antenna is not expensive or unwieldy, in fact it is smaller than the usual outdoor TV antenna. A five-element antenna is sufficient, and can be purchased at a reasonable price from Newark Electric Co., Allied Radio, or any similar Amateur jobber.

You should equip your beam antenna with a suitable rotating-device, (one of those sold for TV antenna use will do very well) and you should get it as high above the ground as you can. A "quick and dirty" rule is that you can reliably work one mile of range per foot of antenna height (above average ground) beyond ten feet. In other words, this is your **consistent** communication range, in miles.

While you can make a number of contacts, particularly in the New York, New England, and Chicago areas, with a dipole in the attic, a good beam will do more for your morale than anything else.

- 2) A grid-dip meter. Stray capacitance and inductance being unpredictable in most cases, it becomes necessary to individually trim VHF tuned circuits by trial in nearly every case. The proper tool for establishing these resonant frequencies is the grid-dipper.

- 3) A volt-ohm-milliammeter.



ometer and R-T switch. Connect the receiver tuning capacitor to the vernier tuning dial with a piece of 1/4-in. fiber or plastic rod and a shaft coupling. A setting of zero upon the tuning dial should correspond to maximum capacity, lowest frequency.

Plug the 6E5 tuning-eye tube into its socket, and fit it into the clamp provided on its bracket. Bring the cable from the tuning eye socket through the chassis through a 3/8-in. hole with rubber grommet. Connect the black and blue wires of this cable to ground, the green wire to the 6.3-v heater supply, and the red wire to the positive high voltage.

Install the 1N34 crystal diode, the 5000 mmf. capacitor, and the 220K resistor in the tuning meter circuit upon a two-lug insulated tie point, being careful to observe the polarity of the crystal diode. Install the diode-resistor assembly close to the final amplifier tank coil. Connect the yellow wire from the tuning eye tube to the ungrounded end of the 220K resistor as indicated in Fig. 14.

Now is the time to connect the receiver input and the transmitter output to the R-T switch through RG-59-U coaxial cable. Ground the outer sheath of each piece of cable firmly to the chassis at both ends of its run. The coaxial cable from the transmitter (center conductor) is tapped one turn from the grounded end of the final tank coil, L4, as shown in Fig. 13A. The receiver cable is run from the R-T switch to the input tie-point on the receiver sub-unit. Bring the cable up through a grommeted hole in the chassis. Next, run a piece of cable from the R-T switch to the antenna terminals on the terminal strip. Connect a short piece of wire—not over 1/2 in. long—from the center conductor of the coax cable (where it connects to the transmitter tank) to the tuning diode.

Finally, run the wire from the R-T switch

to one side of the speaker, passing it thru a de-burred 1/8-in. hole in the chassis. Ground the other speaker voice-coil lug.

Connect the power cord, and microphone to the proper terminals on the terminal strip. Then connect a No. 48 pilot lamp bulb across the antenna terminals. Apply power and, when the tubes are warm, throw the R-T switch to Transmit. The bulb should glow brightly and the tuning-eye should move toward closed position. (If it opens, reverse the connections to the IN34.) Re-tune the final amplifier tank and buffer tank for maximum glow from the bulb. Note also that the eye closes most when the output is at a maximum. Speak into the mike and note the variation in bulb brilliance and eye closing as you speak, indicating proper modulation.

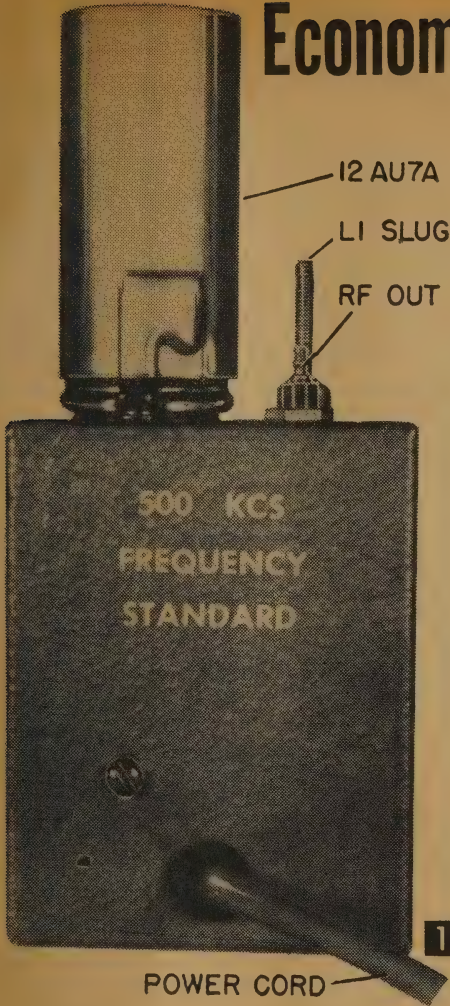
Now, remove the lamp bulb, and connect a 144-megacycle antenna system, preferably a good, high, beam antenna. Make sure the grounded terminal of the antenna feed coaxial cable is connected to the grounded terminal on the terminal strip. Throw the R-T switch to Receive and adjust regeneration for a smooth hiss. If there are any other two-meter amateur stations operating in your vicinity, you should hear them with no difficulty. Now throw the switch to Transmit position and adjust the final tank capacitor to close the eye as completely as possible. You're tuned-up and ready to go.

Novices learning the code, may wish to operate in the modulated code, MCW mode, which is legal in the 144-megacycle band. To use, throw the toggle switch into the open (MCW) position, and substitute a telegraph key, in series with a 220K resistor, for the microphone. Otherwise operation is identical to voice. The smooth, tone-modulated CW signal radiated can be read by other amateurs, regardless of the receiver employed.

Economy Frequency Standard

Here is a versatile frequency standard that the amateur, SWL, or experimenter can build in one evening for about five dollars

By JOE A. ROLF, K5JOK

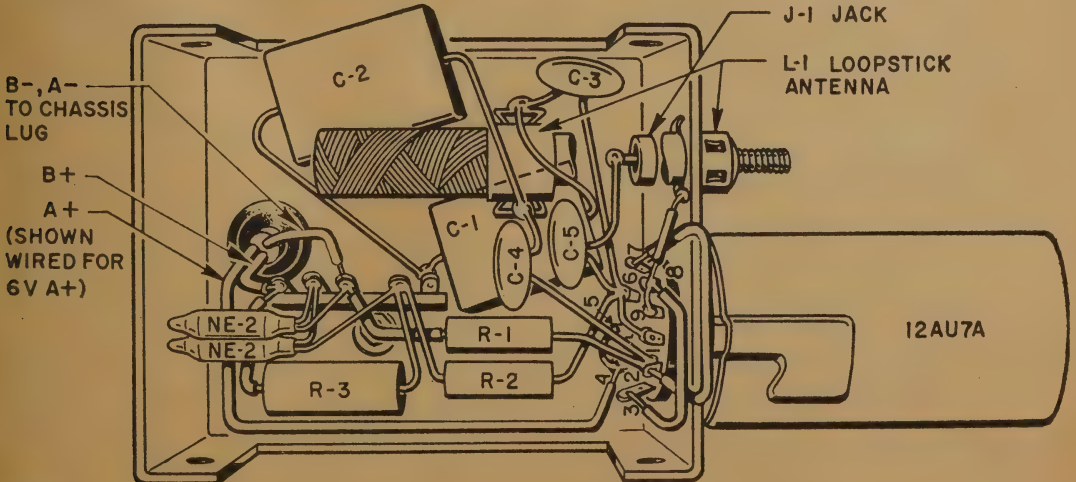


THIS compact frequency standard will enable you to calibrate your receiver and check its accuracy at will. It can also be employed as a beat frequency oscillator for receiving CW signals, and for other applications requiring a stable 400 Kc to 1200 Kc RF generator.

The circuit shown in Fig. 3 is a high-C Colpitts oscillator using a parallel connected 12AU7A. Excellent frequency stability is achieved by the use of a high-Q loopstick as tank coil and a large value of tank capacity. Two NE-2 neon lamps regulate the oscillator plate voltage for added stability. With rigid construction and good shielding, the circuit has negligible drift after initial warm-up.

For maximum compactness, the unit is constructed in a 1½ x 2½ x 2¾ in. Minibox (CU-2100). Construction details are shown in Figs. 2 and 4. The 12AU7A is mounted outside the cabinet to avoid heating frequency-determining components. The output jack, J1, and tank coil, L1, are mounted beside the tube socket. Inductance L1 should be securely mounted and reinforced with a bead of Duco cement to insure against possible vi-

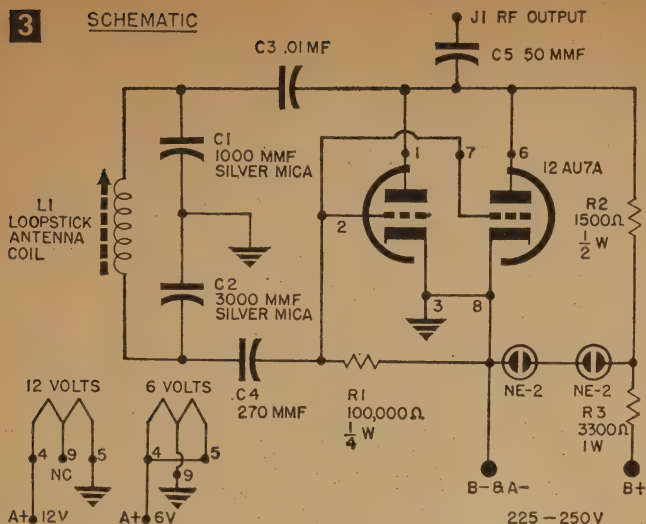
Frequency standard is powered from an external source. Designed primarily for 500 Kc, it can be tuned from 400 Kc to 1200 Kc.



2 PICTORIAL

Components C3, C4, C5 and R1 are mounted to the tube socket beneath C1. Jack J1 is mounted behind L1.

3 SCHEMATIC



MATERIALS LIST—FREQUENCY STANDARD

Desig.	Description
C1	1000 mmf silver mica capacitor
C2	3000 mmf silver mica capacitor
C3	.01 mfd disc ceramic
C4	270 mmf mica capacitor
C5	50 mmf mica or disc ceramic
J1	small feed-through insulator, coax jack, or phone tip jack
L1	ferri-loopstick antenna coil
NE-2	NE-2 neon lamp (two required)
R1	100,000 ohm, $\frac{1}{4}$ watt resistor
R2	1,500 ohm, $\frac{1}{2}$ watt
R3	3,300 ohm, 1 watt
1	Cu-2100 Minibox
1	12AU7A tube
1	3-conductor cable, length as desired
1	5-lug terminal strip
1	9-pin miniature tube socket
3	$\frac{1}{8} \times \frac{1}{4}$ " machine screws and nuts
1	$\frac{3}{16}$ " rubber grommet
	tube shield, decals, etc.

this switch can be included in the Minibox.

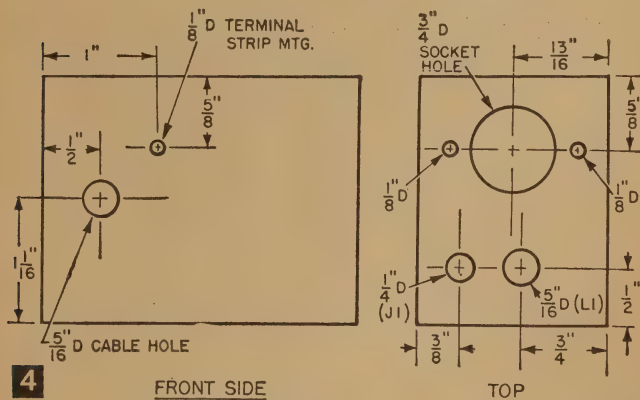
Adjustment of the slug on L1 permits the unit to be set at any frequency from about 400 Kc to 1200 Kc. This permits a number of applications, the most obvious, of course, as a 500 Kc or 1000 Kc frequency standard. When tuned to 500 Kc, useful harmonics will appear at 500 Kc. intervals up to about 15 Mc. Above 15 Mc, 500 Kc harmonics rapidly become too weak for easy receiver calibration and it is necessary to shift the standard's setting to 1000 Kc to get harmonics of useful amplitude above 35 Mc. The unit can be accurately adjusted to either frequency by zero beating WWV at 2.5 Mc, 5 Mc or 10 Mc.

As a frequency standard, the unit is small enough to fit inside most receiver cabinets. In most cases, a short length of insulated wire connected to J1 and brought near the receiver input circuit will provide sufficient coupling.

However, you may find that with some receivers or with less than 225-v plate voltage, it may be necessary to connect the standard directly to the receiver antenna terminal with a 5-30 mmf mica capacitor.

Another useful application, for the SWL or amateur, is as a BFO (beat frequency oscillator) for 455-Kc IF receivers. The standard can be tuned to the IF frequency and connected to the grid or plate lead of the receiver's last IF stage with a 2 to 5 mmf capacitor for CW reception employing an all-wave set or an automobile receiver.

Note that Fig. 2 is shown wired for a 6-v filament supply, pin 9 of the 12AU7A grounded, pins 4 and 5 tied together. If you are using a 12-v filament supply, pin 9 will have no connection, pin 5 is grounded, and pin 4 is wired to the 12 volts (see Fig. 3).



bration. Jack J1 may be a small feed-through insulator, miniature coax jack, or phone tip jack. Power is furnished by an external source and brought into the cabinet by a three-conductor cable.

It is important, from the standpoint of stability, that wiring be as rigid as possible. Connections between socket pins 2 and 7, and pins 1 and 6, should be made with heavy solid copper wire. Pins 3, 8, and 9 are grounded at the tube socket; other leads should be kept short and rigid to avoid vibration. Keep components away from L1 as much as possible and use quality silver mica capacitors for C1 and C2.

The oscillator is designed to operate with plate voltages from 225 to 250 v at about 15 ma. In most cases these voltages are available from the receiver with which this frequency standard will be used. Less than 225 v can be used if R3 is replaced with a 500 ohm, 1 watt resistor. Filament connections for either 6 or 12 v are shown in Fig. 3. The oscillator is turned on and off by a SPST switch in the external B-plus lead. If desired,



1

Two-Tube Long Wave Receiver

This compact ac-dc receiver features good sensitivity, better than average selectivity, and simplified construction. It has an adjustable tuning range of 85 to 550 kc. and is easily modified for broadcast-band reception

By JOE A. ROLF, K5JOK

THE circuit of this economical receiver (see Fig. 4) employs two miniature high-gain TV tubes. The 6AN8 is a regenerative detector; the pentode section of the 6AU8 is an audio amplifier. The triode of the 6AU8 serves as an ac-dc type rectifier.

The heart of the circuit is the detector, a regenerative cathode-follower type commonly known as the "Regenode." If you're not familiar with this hybrid circuit, here's how it works: The pentode section of the 6AN8 is a conventional grid-leak detector, with the exception of the signal grid which is separated from the tuned antenna circuit by the cathode-follower connected triode section of the tube. This arrangement permits a degree of selectivity not possible with the detector

grid connected directly to the antenna circuit, since the signal-grid loads the tuned circuit and reduces its Q, or selectivity ability. The cathode-follower isolates the detector from its input circuit and allows a great improvement in selectivity. The circuit operates smoothly, is easily adjusted, and eliminates hand-capacity effects common to most regenerators. These advantages are particularly desirable in a LW receiver.

Since hand capacity does not affect operation, an all-wood chassis constructed with simple hand tools can be used. Chassis details are shown in Fig. 5. Large holes (for tube sockets and controls) can be made with a coping saw; fastener holes can be made with a hot ice-pick in the absence of a drill. A



YOU'LL be pleasantly surprised at the number of interesting signals to be heard below the standard broadcast band, though at first they may sound like nothing but jumbled dots and dashes intermixed with weird howls and squeals. Careful listening, however, will reveal this apparent bedlam to be important communication services which make unusual listening and challenging DX.

The main divisions of the 10 Kc. to 535 Kc. band are shown in Table A. It is occupied mainly by aeronautical and marine services, although 150-535 Kc. is part of the standard BC band in Europe and Asia. However, without discounting the possibility of logging some of these BC stations, the marine and aeronautical stations are of prime interest to most LW listeners.

What to Listen To on LW

The long waves provide up-to-the-minute reports on weather and flying conditions, code practice and some good DX

The most popular are the navigational aids, or radiobeacons, heard between 200 Kc. and 405 Kc. Some are marine beacons, others aeronautical. Both employ very slow amplitude modulated code and are easily distinguished from one another by their signals.

Marine beacons usually transmit their call signs continuously in an omni-directional pattern. In some cases the call, consisting of from two to four letters or numerals, is separated by a number of dashes. Many marine beacons can be heard constantly over a considerable range, while the less powerful can be logged at great distances under favorable conditions.

Aeronautical range stations transmit a combination A-N signal in a four-leaf pattern like that of Fig. 1. They identify themselves every thirty seconds and employ two pairs of antennas to obtain the four-leaf radiation pattern. The transmitter is operated continuously and is alternately switched between the two antenna systems so that an A (dit dah) is radiated in the directions marked A in Fig. 2, and an N (dah dit) in the directions marked N. Midway between the A and N patterns, the signals merge as a steady tone which aircraft follow to or from the station. If the pilot leaves this course, he will hear either the A or the N.

These radiobeacons offer an unlimited

metal chassis will afford more compact construction, but a wooden panel and cabinet should be used to avoid accidental grounding of the chassis.

Construction is not critical and will pose no difficulty if the general layout shown in Figs. 2, 3, and 5 is followed. Keep RF and AF leads separated and away from ac leads. This is best accomplished by wiring the filaments and power supply first, then the AF and detector stages.

Ground connections are made to solder lugs mounted to the socket and tuning capacitor fasteners. Components R4, R6, R9 and R10 mount on a 7-lug terminal strip at the rear underside of the chassis (see Figs. 3 and 4). The filter capacitor, C11, can be wedged between the 6AU8 socket and chassis leg, or secured with a mounting clip. Two sections of this capacitor are used in the power supply

filter, the third is used as a cathode bypass for the audio stage.

Other components under the chassis, except R3, C7 and C9, mount to respective tube sockets. Capacitor C9 is connected from J2 to the grounded terminal on R5. Resistors R3 and C7 connect to a machine screw and solder lug placed between L1 and C2. One lead of L2 connects to a solder lug on the same screw on the chassis top.

The antenna trimmer, C1, is secured by the antenna terminal mounting screw as shown in Fig. 3. This component requires only infrequent adjustment, but it can be mounted on the front panel for easier access, if desired.

Inductance L1, a standard TV replacement coil, is mounted last. Before inserting the core, as explained in the manufacturer's instruction leaflet, thread on the $\frac{5}{16}$ -in. mounting clip and remove $\frac{1}{2}$ in. from the slotted

TABLE A—LONG WAVE ALLOCATIONS

Frequency (Kc.) Communications Service Sunset Skip Night DX

10-14	Radionavigation	none	4 am
14-200	Fixed Public Services and Coastal-Marine CW		
200-283	Aeronautical Beacons and Communications		
285-325	Marine Radiobeacons		
325-405	Aeronautical Beacons and Communications	10 pm to 2 am	7 am
405-415	Radio Direction Finding		
415-490	Coastal and Marine CW		
500	International Calling and Distress Frequency	2-4 hours after sunset	11 pm to 7 am
510-535	Misc. Radiobeacons		

Note: Frequencies between 150 Kc. and 535 Kc. also used by foreign BC stations.

source of unusual DX. At first sight, these stations seem to offer poor DX since most are relatively low powered and have a daytime range of less than 200 miles. However, their range is greatly increased at night—best times for night DX are given in Fig. 1. These hours will vary somewhat with the seasons, with the choicest DX being heard from early fall to late spring.

Above 325 Kc. sunset skip is often heard for a half-hour during early darkness. Notable examples are PJG, 343 Kc. in the Netherlands Antilles; ASN, 350 Kc. on Ascension Island; and SWA, 406 Kc. from Swan Island.

Since beacons identify continuously or every thirty seconds, less than a minute is required to log a station. However, in order to determine the locations of the stations you

TABLE B—STATION LISTS

The Airman's Guide	Superintendent of Documents, Washington 25, D. C. 25¢ per copy. A bi-weekly publication listing all U. S. aeronautical radio beacons.
Location Identifiers	Superintendent of Documents, Washington 25, D. C. \$1.50 for copy, and one-year supplement service. General listing of all domestic beacons.
Broadcasting Stations of The World, Part II, According to Frequency	Superintendent of Documents, Washington 25, D. C. \$2.00. Includes European LW broadcasting stations.
Air Navigation Radio Aids	Department of Transport, Air Service Branch, Ottawa, Ontario, Canada. Complete list of Canadian Radio Beacons, published every two months.
Radio Facility Charts—Caribbean & South America	ACIC, USAF, 2nd & Arsenal Streets, St. Louis 18, Mo. One year subscription \$3.50. Listing of Caribbean & South American beacons.
Radio Navigational Aids	Hydrographic Office, U. S. Navy. An annual publication listing worldwide marine beacons.
List of Coast Stations (4.10 Swiss francs)	Secretary General, International Telecommunications Union, Geneva, Switzerland. Very complete listings of worldwide stations.
List of Ship Stations (12.80 Swiss francs)	
List of Call Signs (21 Swiss francs)	

hear, you need a reference log listing the stations you are interested in. Such listings can be purchased (see Table B).

Range stations also transmit verbal weather reports for air fields in their area 15 minutes before and 15 minutes after the hour.

In addition to radiobeacons, many CW stations operate on long waves for maritime, aeronautical, and public service communication. For the CW enthusiast, these are interesting to copy and the slower stations, sometimes sending as slow as eight words a minute, provide plenty of code practice. Many good DX signals can be heard between 415 Kc. and 500 Kc., particularly on the 500 Kc. international calling and distress frequency. The frequencies below 200 Kc. are also widely used by public service and maritime CW stations.

end of the core adjustment screw, otherwise it will protrude below the chassis when the coil is mounted. Clamp the section to be removed in a vise and cut it off with a hacksaw, then cut a new screwdriver slot. Take care not to break or fracture the fragile ferrite coil.

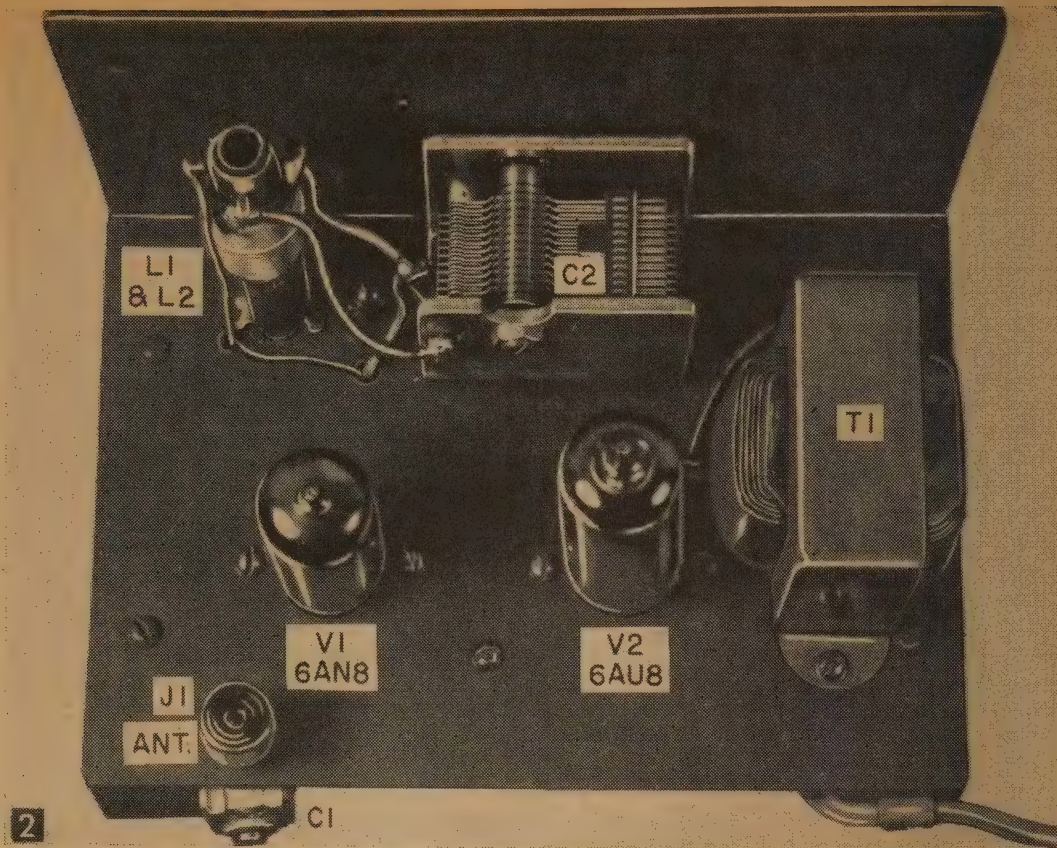
Inductance L2 consists of 35 turns of #26 (or smaller) enameled wire scramble-wound over a $\frac{1}{16}$ in. ID tube which slides freely over L1. If not available, this form can be made by winding four or five layers of moist gummed tape, sticky side out, over L1. When dry, slip the tube off and trim to proper length with a razor blade. With L2 in place, secure L1 to the chassis with a bead of Duco cement.

For maximum sensitivity, the position of L2 on L1 should be adjusted for the individual receiver. This simple adjustment is well

worth the effort and can be made with a long antenna, 455 Kc signal generator, or a BCB receiver with a 455 Kc intermediate frequency. If possible, use a signal generator or BCB receiver, since this will permit adjustment of L2 and the core of L1 at the same time.

Short out L2 temporarily by connecting a short piece of wire from the R3-C7 solder lug to pin No. 7 of the 6AN8 socket. Turn the core adjustment screw full counterclockwise and connect the antenna, signal generator, or BCB receiver to the antenna terminal.

If a BCB set is used, tune to a strong BCB station and turn the set's volume down. Connect a short piece of insulated wire to your LW receiver antenna terminal and place it near the underside of the BCB set's IF tube socket or IF transformer to hear the 455 Kc IF signal of the BCB receiver.



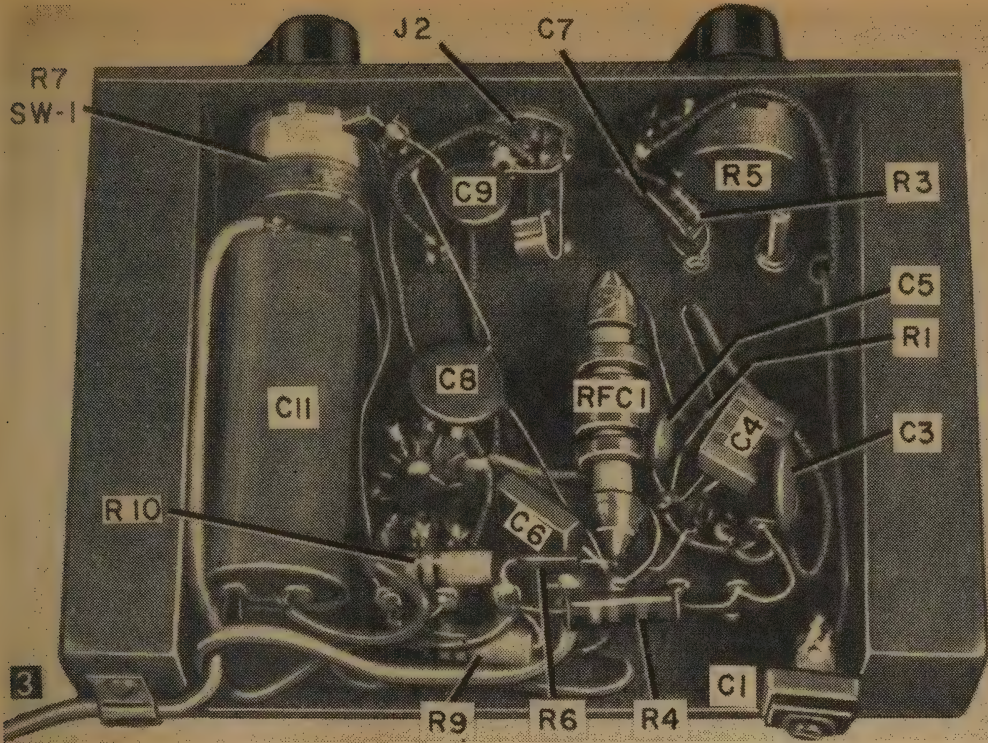
Topside of the receiver's Masonite chassis. The antenna coil, L1, is mounted so that its slug is adjusted from below the chassis.

MATERIALS LIST—LONG WAVE RECEIVER

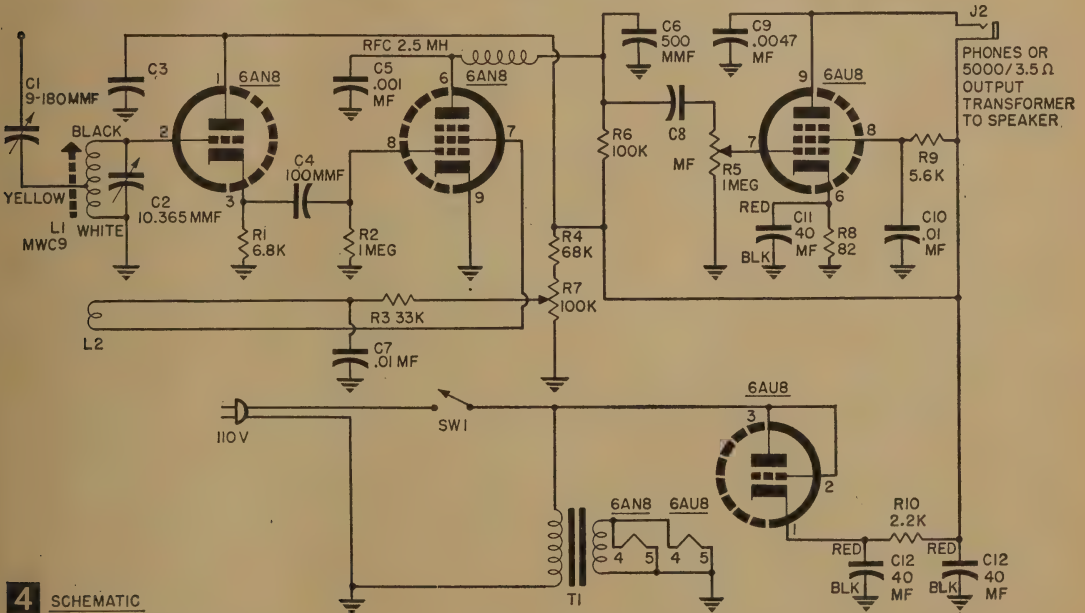
Desig.	Description	Desig.	Description
C1	9 to 180 mmf trimmer capacitor	R10	2.2 K, 1 watt
C2	10 to 365 mmf variable capacitor, standard single-gang TRF type	J1	antenna terminal post, or Fahnestock clip
C3	.01 mfd disc ceramic	J2	standard phone jack
C4	100 mmf mica	L1	Long Wave: Merit MWG-9 Width or Linearity coil, .3 to 12 ma., tapped (see text)
C5	.001 mmf disc ceramic	L2	Broadcast: Ferri-loopstick BCB antenna coil (see text) Long Wave: 35 turns #26, or smaller, enameled wire scramble wound on $\frac{1}{16}$ " ID x $\frac{3}{8}$ " form (see text) Broadcast: 3 turns #26, or smaller, enameled wire on adjustable form (see text)
C6	500 mmf mica	RFC1	2.5 mh. RF choke (National R-100, or equivalent)
C7	.01 mfd disc ceramic	SW1	on R7
C8	.01 mfd disc ceramic	T1	filament transformer, 6.3 vct, 1.2 amp (Stancor P-6134 or equivalent)
C9	.0047 mfd disc ceramic	T2	optional—for speaker use only; 5000/3.2 ohm, 3 watt, 40 ma, output transformer. (Merit A-3026, or equivalent)
C10	.01 mfd disc ceramic	V1	6AN8
C11	40-40-40 mfd, 150 vv capacitor, 3-section electrolytic filter capacitor (Cornell-Dubilier BBRT 44415, or equivalent)	V2	6AU8
R1	6.8 K, $\frac{1}{2}$ watt resistor	1 pc	$\frac{1}{8}$ x $4\frac{1}{2}$ x 6" Masonite (panel)
R2	1 meg, $\frac{1}{2}$ watt	1 pc	$\frac{1}{8}$ x 4 x 6" Masonite (chassis top)
R3	33 K, $\frac{1}{4}$ watt	1 pc	pine strip, $\frac{3}{4}$ x $1\frac{1}{8}$ x 4" (chassis sides)
R4	68 K, 1 watt	2 pcs	two miniature 9-pin tube sockets
R5	1 meg, $\frac{1}{4}$ watt volume control with SPST switch (Mallory U-53 Midgetrol with US-26 switch, or equivalent)		one 7-lug terminal strip
R6	100 K, $\frac{1}{2}$ watt		hardware, power cord, dial, knobs, etc.
R7	100 K, $\frac{1}{4}$ watt, volume control (Mallory U-41 Midgetrol, or equivalent)		
R8	82 ohm, $\frac{1}{2}$ watt		
R9	5.6 K, 1 watt		

With the volume control at maximum and the regeneration control set at half-scale, place the tuning capacitor about 85% open and turn L1's core clockwise until the 455 Kc signal is heard. Adjust the regeneration control for maximum volume and mark its position. This is the detector's most sensitive

point and will determine the position of L2. Remove the jumper across L2 and slide the coil up or down over L1 until regeneration (signal distortion) occurs just above the point previously marked on the regeneration control. If the detector fails to regenerate, reverse the leads on L2.



Under-chassis view, showing placement of components.

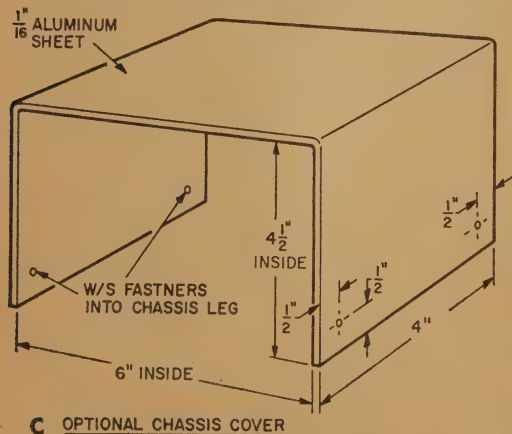
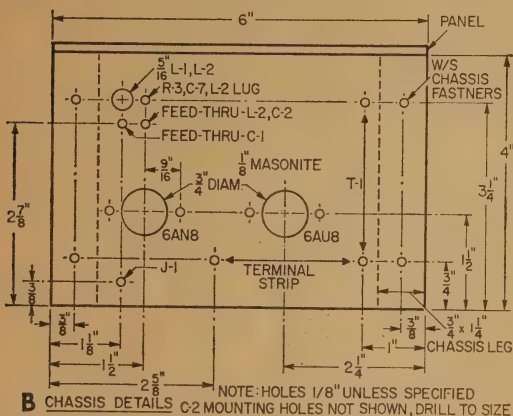
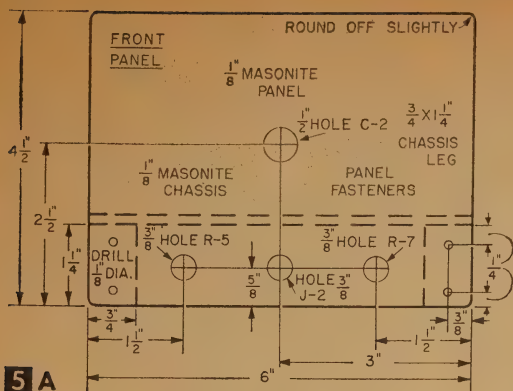


4 SCHEMATIC

This receiver's tuning range, from 85 to 550 Kc, is covered in two adjustments of the core on L1. When set to receive 550 Kc at C2's minimum capacity, the receiver will tune down to about 200 Kc. The range from 85 to 200 Kc is tuned when the slug is almost fully inserted into L1. Overlap on both bands will

permit easy bandchanging once the operator is familiar with the stations heard around 200 Kc. On the lower band, L2 may require slight readjustment for best reception of weak signals.

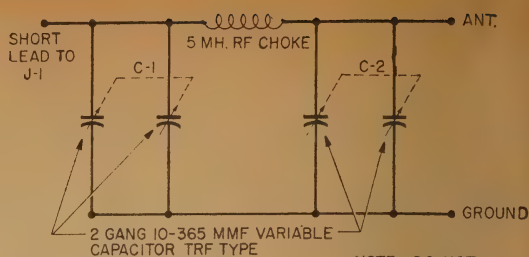
For BCB reception, a ferri-loopstick is used for L1. Inductance L2 consists of three turns



and adjustment is similar to that of LW operation. The lead from C1 should be connected to the grid end of the loopstick.

A high, long-wire antenna will give best all-round LW reception, though a short length of wire will give satisfactory local reception. Capacitor C1 should be adjusted for best reception on each band and the receiver should not be grounded.

In some localities, interference from strong BCB stations may be bothersome, a trouble commonly encountered with LW receivers having only a single tuned circuit. Such in-

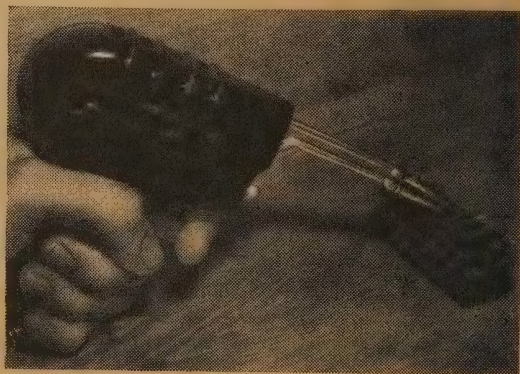


terference can be minimized by reducing the antenna coupling or, in severe cases, by the use of the simple Pi antenna tuner (shown in Fig. 6). The tuner can be built on a small pine block. Adjust C1 and C2 for minimum BCB interference.

Four or five feet of hookup wire is sufficient antenna for BCB reception. The receiver will give good loudspeaker volume on the BC band and on the stronger LW stations. Due to the low power used by most LW stations, however, headphones are recommended for serious LW listening. For speaker operation plug a 5000-3.5 ohm, 3-watt, output transformer into J2.

Inverted Brush Cleans Gun's Tip

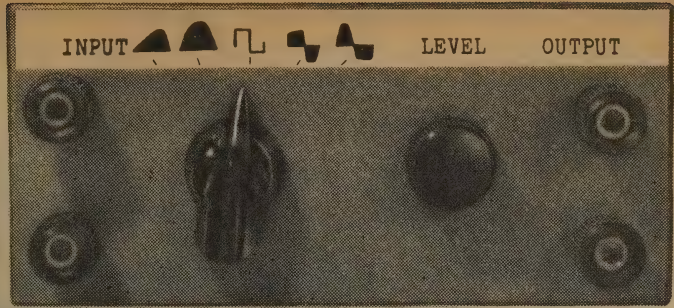
● To keep the tip of your soldering gun clean of scale, woodscrew-fasten a brass-bristle suede shoe brush to one end of your workbench. Wipe the soldering-gun tip across the brush occasionally to keep it clean for efficient soldering.—J.A.C.



Why Inside Gun-Tip Care?

● To receive maximum soldering efficiency and long-tip life, be sure that cleaning and tinning operations of your soldering gun's tip also include the *inside* surfaces of the tip. A gun's tip that is maintained on the outside, but allowed to deteriorate on the inside, is sure to give lowered soldering efficiency and it will shorten tip life.

This small grey box performs the electronic hocus-pocus that will convert sine waves into varied waveforms.



WAVEFORMER

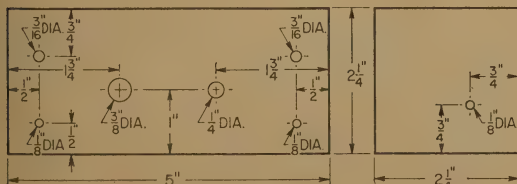
This inexpensive instrument converts 60-cycle ac or audio generator sine waves to sawtooth, half-sine, clipped half-sine, and square waves

By FRANK WOODS, Jr.

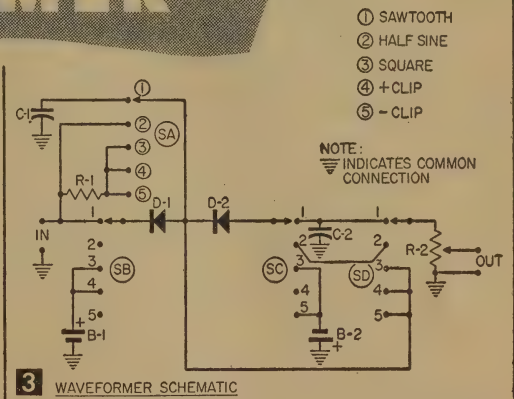
This waveformer is inexpensive (cost: less than \$5) and simple to construct. The waveforms generated by it can be used to drive sweep circuits, test amplifiers, check amplifier response, synchronize other equipment, and a host of other test and experimental jobs.

A sine wave is applied to the input terminals, and the switch next to the input terminals is set for the desired waveform; the level control is set for the desired output level. The desired voltage waveform will then be present at the output terminals on the right of the case. It's almost that simple.

Construction. Lay out the front half of the metal case as shown in Fig. 2. All components mount on this half of the case; the back is merely a cover. Mark hole starter marks on the case with an ice pick. Then, with the front and back of the case fastened together,



2 PANEL LAYOUT

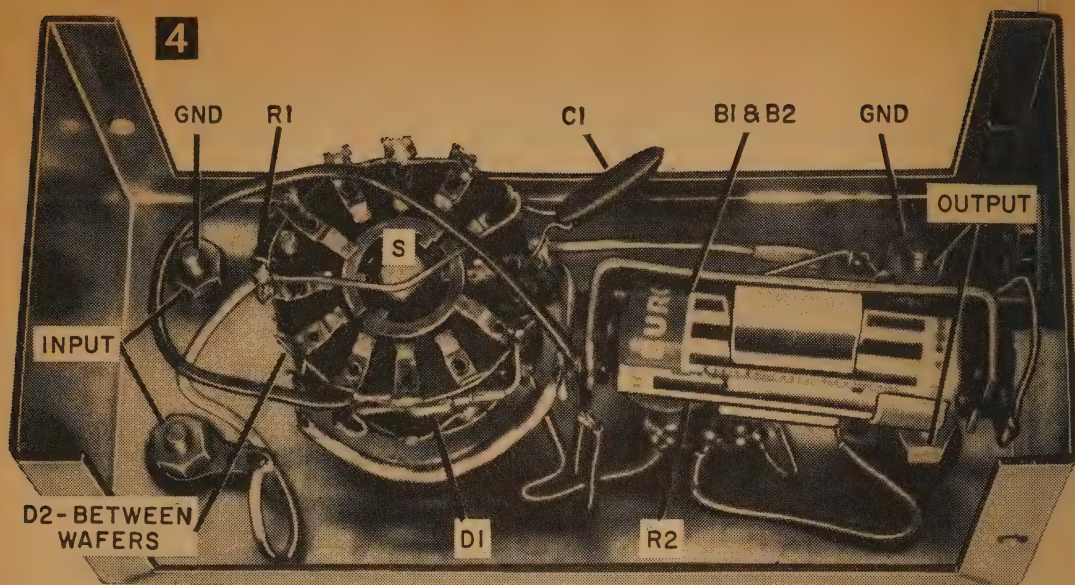


3 WAVEFORMER SCHEMATIC

drill $\frac{1}{8}$ -in. holes for all positions. Separate the front and back of the case and enlarge the specified larger holes to the required dia. with a taper reamer. File the edges to remove burrs.

Saw the shaft of the switch to a length of $\frac{1}{2}$ in. Saw the level control shaft to a length of $\frac{3}{8}$ in. To avoid damaging switch and level controls, grip shafts in a vise when sawing. This prevents side pressure on bushings. Catch the switch or control when it is cut free from the shaft. The switch is ruggedly constructed, but it is subject to easy damage since its wafers are brittle.

Mount the input and output terminal binding posts. The bottom-chassis terminals are the common terminals; they make electrical contact to the metal case. The top-chassis terminals are insulated from ground by fiber washers between the binding post and the front of the case and between the retaining nut and the rear of the case, and by centering the binding posts. Note that the holes for the top binding posts are larger than those for the bottom. In the original model soldering lugs were used to permit soldering of binding post leads. A second nut on each binding post holds the soldering lug in place. But, the



Component layout of Waveformer.

MATERIALS LIST—WAVEFORMER

Design.	Description
R1	100K, 1/2 W carbon resistor 10% tolerance
R2	500K potentiometer (Lafayette VC-37)
C1, C2,	.1 mfd, 50 v ceramic capacitor (Sprague TG-P10)
S (A, B, C, D)	4-pole, 5-position switch (Centralab PA-1013)
D1, D2	1N54A diode (RCA)
B1, B2	penlite cell (Burgess #7)
	2-penlite cell holder (Lafayette MS-138)
	pointer knob (comes with switch)
	miniature knob (MS-185)
	binding posts (H. H. Smith 220R-red and 220B-black)
	2 1/4 x 2 1/4 x 5" metal box (Bud CU-2104)

soldering lugs are unnecessary since the connecting wires may be fastened between the two nuts.

Mount the switch and the level control on the case. Use retaining hex nuts on these controls behind the panel. Adjust to allow only enough of the control to protrude through the case to enable the hex nuts to be fastened on the front of the panel. Retaining washers between the rear retaining nuts and the rear of the panel will prevent the controls from slipping. At this point in the construction the components which fasten to the case are mounted—except for the battery holder.



When wiring, make connections to the switch so that they can readily be disconnected without damage. This approach will save you grief if you make a mistake in your wiring. Be very careful not to exert undue pressure on the switch terminals or you may twist them out of place or break a wafer.

Limit the length of time that you apply heat during soldering. The diodes in particular are susceptible to heat damage. Use a clean soldering iron capable of supplying a large amount of heat. A lot of heat applied for a short time will do a better soldering job with less chance of damage than a reduced amount of heat applied for a long time. Use *rosin core* solder only!

Figure 3, the circuit diagram, and Figure 4, a pictorial view, are used as a guide for wiring. Wire the switch first. Note that its sections are designated SA, SB, SC, and SD. Section SA is the lower half of the rear wafer; SB is the upper half of the rear wafer; SC is the lower half of the front (nearest the front panel) wafer; SD is the upper half of the front wafer. Connect the wires between terminals as shown and wire in components R1, D1, and D2.

Next, connect capacitors C1 and C2. Then connect the wires which run from the switch and capacitors to the terminals, level control and battery holder.

Now mount the battery holder and make connections to it. The battery holder is mounted with a small hardware bracket 3/8-in. wide with 1-in. and 5/8-in. sides. Solder-fill the battery holder eyelets which form the battery contacts to insure good connection to the batteries. Insert the batteries and fasten the knobs on the switch and level control. Fasten the back to the case. The markings for the front panel are made on a strip of paper 3/8 x 5 in.

Free-hand the waveform symbols which identify switch positions and fasten the strip to the front of the case with a 6-in. strip of cel-

lophane tape. You may have to realign the switch knob to match the waveform markings.

Operation. To use the waveformer connect a source of sine wave signals to the input terminals as shown in Fig. 5.

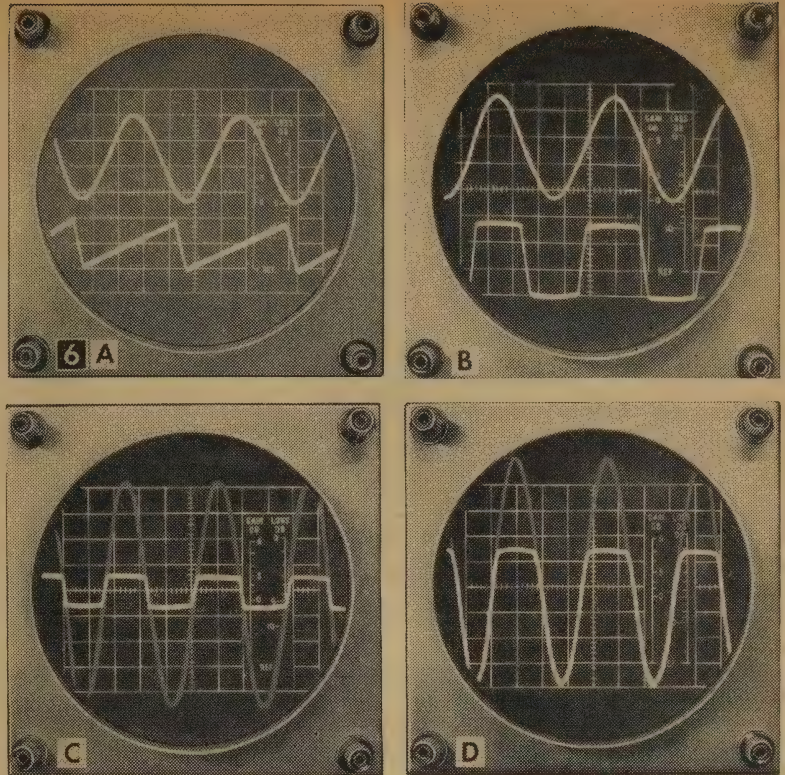
The signal generator may be a 6.3-v filament transformer (supplies 60 cycles only) or an audio signal generator such as the Heathkit AG-9 (frequency 10 cycles upward).

The Waveformer operates through a broad range of frequencies; principal limitations of frequency are imposed by the signal generator for most waveforms. A signal input level of 5 to 15 v is desirable to achieve the best waveforms.

Clean saw-tooth waveforms from about 10 cycles to about 10,000 cycles at .3 v will be produced by a 10-v sine wave. Clean clipped waves from 1.5 to several volts, with a frequency range from 20 cycles to over 20,000 cycles, can be expected.

Science Fair Demonstration. To demonstrate the performance of the Waveformer, a Heathkit AG-9 Audio Generator fed a sine wave to the Waveformer and to a Heathkit S-3 Electronic Switch. The output of the Waveformer was fed to the other set of Electronic Switch input terminals. The output of the Electronic Switch was connected to the vertical input of the oscilloscope. This arrangement permitted simultaneous viewing of the Waveformer input and output waveforms.

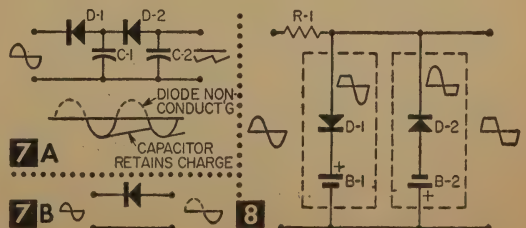
Figure 6A shows the waveform output with the Waveformer switch set for saw-tooth output. Figure 6B shows the output with the Waveformer switch set for square wave. In Fig. 6C the input and output waveforms are superimposed with gains adjusted to show how the Waveformer clips the sine wave. The "squareness" of the output waveform will depend on the magnitude of the input sine wave signals. With larger sine wave input signals, the clipping action produces "squarer" waves. Figure 6D shows the superimposed waveforms with the Waveformer switch set to one of the half-clip positions.

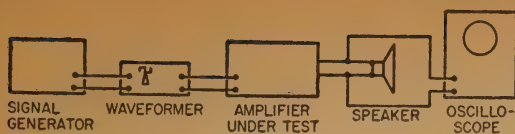


Simultaneous viewing of input to, and output of Waveformer. Explanation is given in text.

Principles of Operation. When the Waveformer switch is set to the sawtooth-wave position, the basic waveforming circuit connections are those shown in Fig. 7A. First consider only D1 and C1. Diode D1 passes only the negative portion of the sine wave. As the sine wave goes negative, capacitor C1 charges rapidly in the negative direction. This produces the steep portion of the curve. As the input signal falls from the negative peak to the zero line, the charge on C1 prevents further passage of current through D1 and capacitor C1 tends to discharge slowly through any load resistance connected across it. The use of D2 and C2 in the circuit improves the performance by providing additional storage and switch action.

When the switch is in the half-wave position the waveforming circuit reduces to that shown in Fig. 7B with diode D2 only in the





9 SET-UP FOR SQUARE WAVE AMPLIFIER TESTING

circuit. It passes only the negative half cycles.

With the switch in the square-wave position, the basic waveforming circuit is that shown in Fig. 8. As the input voltage builds up from zero, current flows through R1 to the output. But when the voltage becomes sufficiently high (greater than 1.5 v) to cause diode D1 to conduct, the current is shorted and the straight top of the wave results. As the voltage decreases toward the zero line, diode D1 ceases to conduct when the voltage to the anode becomes 1.5 v, and the return to zero portion of the waveform results. Diode D2 and bias battery B2 operate on the negative half cycle in the same way. Only R1, D1, and B1 or R1, D2 and B2 are connected in the circuit to produce the half-clipped sine waves.

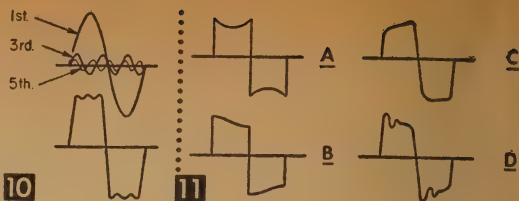
The level control R2 is a potentiometer which permits the setting of a desired output signal level. It is common to all switch positions.

The Waveformer is useful as a teaching tool to explain the operation of diodes, capacitors and pulse circuits, but it has more immediate practical applications. The sawtooth waveform may be used to provide sweep voltage for an oscilloscope. Some of the older inexpensive 'scopes employ sweep circuits that are extremely non-linear and tend to bunch a sine wave applied to the vertical input. If the sawtooth wave of the Waveformer is applied to the horizontal amplifier input of the oscilloscope, the linearity will be improved—if the amplifier has sufficient gain and frequency response.

The half-wave waveform may be used to drive a relay or any other dc device at a specified frequency. Of course, the device to be driven must be of sufficiently low power to allow operation with the signal generator used and the diode in the waveformer. The driven device cannot be operated at frequencies above those to which it can normally respond. The half-clipped sine waves may be used in similar fashion where an opposite "off bias" is desired.

Square-Wave Amplifier Testing. Clipped sine waves may be used to test audio amplifier frequency response. The square wave is applied to the input terminals of the amplifier and the waveform is observed on an oscilloscope connected across the output terminals of the amplifier (see Fig. 9).

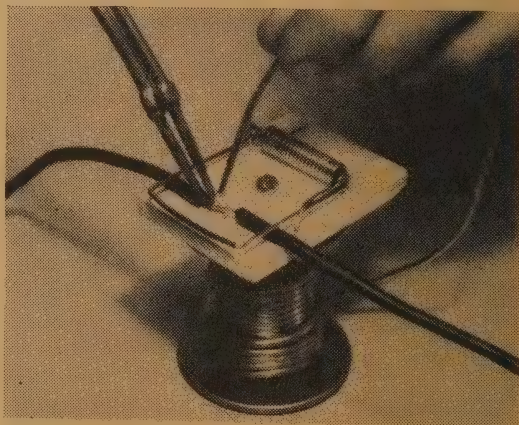
A square wave contains a fundamental frequency sine wave and a large number of higher sine wave components. Figure 10



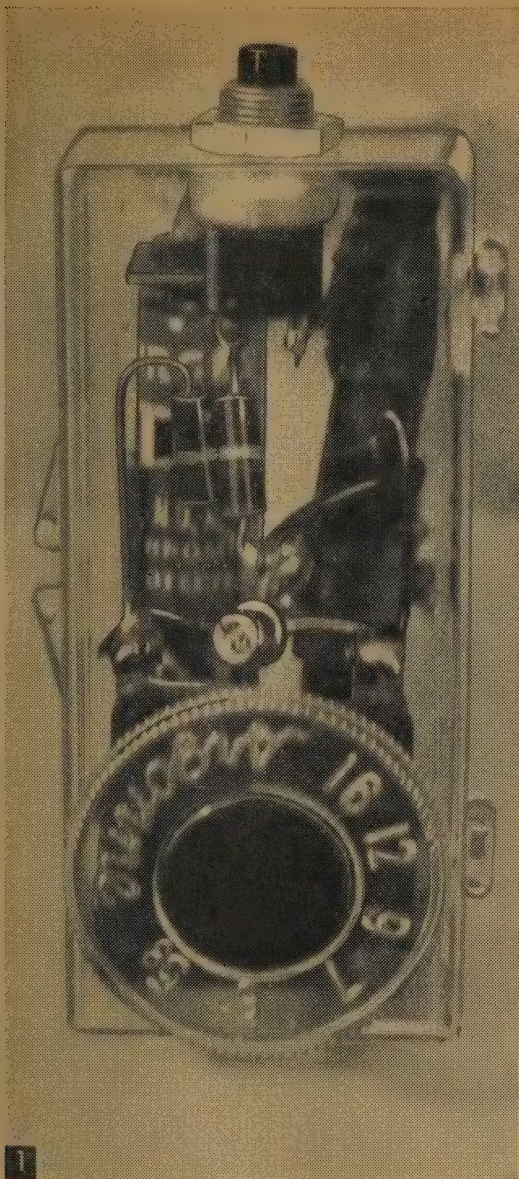
shows the fundamental frequency, the third harmonic, and the fifth harmonic, and how they combine to produce a waveform approaching a square wave. As more odd harmonics of proper phase and amplitude are added, the resulting waveform more nearly approaches a square wave.

Now, if a square wave is passed through an amplifier, amplifier defects will distort the waveform. Discrimination against frequency, and phase shift dependent on frequency (poor frequency response) will produce distinct distortions. If the response of the amplifier is poor at the fundamental frequency, the scope connected at the amplifier output will display a square wave with drooping midsections as shown in Fig. 11A. Phase shift is indicated by a waveform such as that shown in Fig. 11B. Attenuation and phase shift at high frequencies is indicated by an output waveform like that in Fig. 11C. Overshoot and ripples in the displayed waveform, as shown in Fig. 11D, are also indicative of high-frequency distortion. A pronounced high-frequency resonance in the amplifier under test will cause the overshoot to be further accentuated.

Mousetrap Third Hand



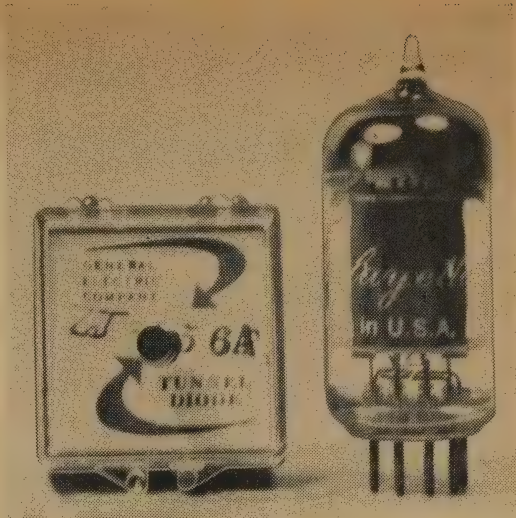
• Need an additional hand to hold small wires and parts while you solder them? To make certain an extra hand is always available when needed, mount the spring mechanism of a mousetrap on the top of your spool of solder as shown. Screw-fasten the mechanism to a tight-fitting cork inserted into the center of the spool.—JOHN A. COMSTOCK.



A simple demonstration construction project, this oscillator employs a tunnel diode which, even in its case (above right), is dwarfed by a vacuum tube.

THIS oscillator is one of the earliest tunnel diode construction projects designed for experimenters. It is an effective demonstration device, and it will attract attention by virtue of its simplicity and the fact that the tunnel diode is a novelty. For the builder, it is a painless introduction to the operation and use of the tunnel diode.

In July 1959 the General Electric Research Laboratory announced progress in the development of tunnel diodes, and offered them in limited quantities at \$75 per unit for labora-

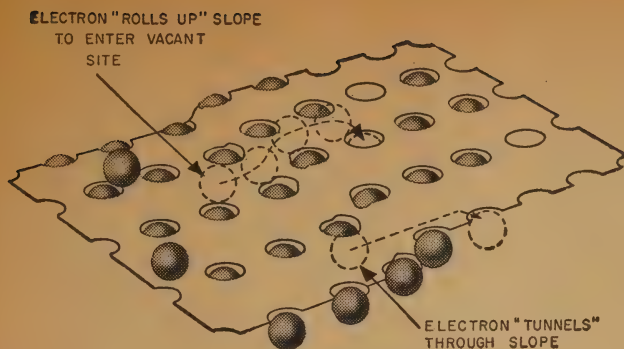


Tunnel Diode Broadcast Oscillator

The tunnel diode—newest member in the fast-growing family of semi-conductors—is giving its first cousin, the transistor, an inferiority complex. Here's a project which helps to explain why

tory use. Prices have been decreasing—thank goodness!—since that time and at the time this article goes to the printer are below \$10. Obtain one now, and get in on the ground floor of an exciting new electronic device. Within a year or two tunnel diode prices should have dropped to a dollar or two a unit, and you will have sufficient knowledge to build the many circuits that are possible with this device. The tunnel diode will be the subject of many science fair and engineering day displays, and it will soon be a common component in TV, communications, computer, and other electronic units.

The circuit of the tunnel diode oscillator



Here—in an extremely simplified diagram—is how the tunnel diode operates. Drawing represents a structure similar to a Chinese checkerboard, with one side slightly raised. Holes on the left side (which represent an n-type semiconductor) are filled with marbles, with a few left over and sitting on top. Right side (representing a p-type semiconductor) has a few holes vacant. The slope represents the potential barrier. A marble (or electron) from the left, can—after being given a push—enter a hole on the right side by rolling up the slope and dropping in. Or, without the push, it can miraculously “tunnel” through the board and appear in a hole. The former process is used in conventional diodes and transistors. The latter represents what happens in tunnel diodes.

THE tunnel diode was first reported by a Japanese scientist—Dr. Leo Esaki—in 1958. It takes its name from the phenomenon that makes its operation possible: quantum-mechanical tunneling.

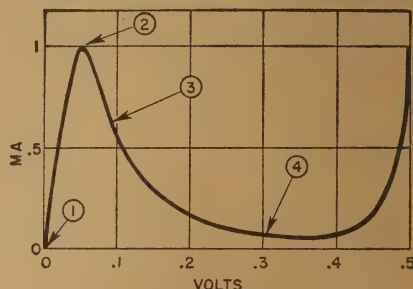
As with transistors, it depends on the transfer of an electrical charge across a p-n junction, the region between a p-type semiconductor, which has an excess of positive carrier or “holes” (empty electron states), and an n-type, which has an excess of free electrons.

The opposite sides of this junction take on a charge which resists the movement of the “holes” and electrons across it. In the transistor, a charge carrier must be emitted into a region where its energy can be boosted by an outside voltage. It is then collected on an output electrode. The speed of this process is limited by the time it takes the charge carrier—having left the emitter—to traverse the control region and appear on the collector. This time limits the frequency at which the device can function and is quite long compared to, say, the time needed for a signal to travel an equivalent distance along a copper wire.

The quantum-mechanical theory says there is another way in which the particles can pass the barrier: an electron has a small, but definite possibility of disappearing from one side of the potential barrier and re-appearing simultaneously on the other—even though it does not have enough energy to surmount the barrier. It is as though the particles “tunnel” under the barrier, setting up almost instantaneous surges of current. Thus, in the tunnel diode, the signal moves with the same speed as it would in a copper wire—the speed of light.

The construction of a tunnel diode gives it some other

Unique Circuit Simplifier THE TUNNEL DIODE



TUNNEL DIODE
CURRENT-VOLTAGE CHARACTERISTICS

PTS ① TO ② - POSITIVE RESISTANCE

PTS ② TO ④ - NEGATIVE RESISTANCE

PT ④ ON — POSITIVE RESISTANCE

interesting characteristics. Its p-n junction is made of materials more heavily loaded—or doped—with impurities than conventional diodes, and made so that the barrier between p and n sections is extremely thin, less than a millionth of an inch thick.

So long as no outside voltage is applied across the p-n junction, there is no net current—since the electrons tunnel back and forth easily through the barrier in both directions. Apply a small voltage, however, and current appears. Add still more voltage, and current decreases. Add more, and current increases again.

In the range where an increase in voltage results in a fall-off of current, the tunnel diode is said to have “negative” resistance—making it suited for use as an amplifier or oscillator.

This negative resistance quality, combined with speed-of-light operation, makes possible a very high frequency response. Engineers confidently expect oscillation frequencies of more than 10,000 megacycles.

Some other outstanding features:

- It is smaller than a transistor and, because of its simplicity, ultimately will be just a fraction of its present size.

- It is affected very little by environment. The tunnel diode can operate at the near-absolute zero temperature of liquid helium or—at the other end of the thermometer—at temperatures up to 650° F, while conventional silicon diodes won't operate above 400° F.

- It has a low noise level, only parametric amplifiers and masers competing closely with it. And of these, only the tunnel diode can operate directly from a battery.

is shown in Fig. 2. Resistors R1 and R2 divide the voltage from the 1.5-v battery down to about 0.15 v, the approximate voltage for negative resistance operation of the tunnel diode. Resistors R1 and R2 were chosen so that R2 would be a fraction (about 1/10th in this case) of the tunnel diode negative resistance (which is about 150 ohms). Inductor L and

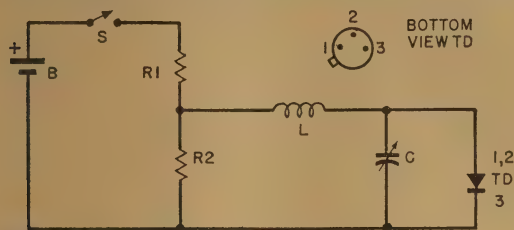
capacitor C form a resonant circuit that controls the oscillations of the tunnel diode, TD. (Several symbols for tunnel diodes have been suggested and are presently used by different manufacturers. The conventional symbol is shown in Fig. 2).

Correct polarity of the voltage applied to the diode is important—Be careful not to re-

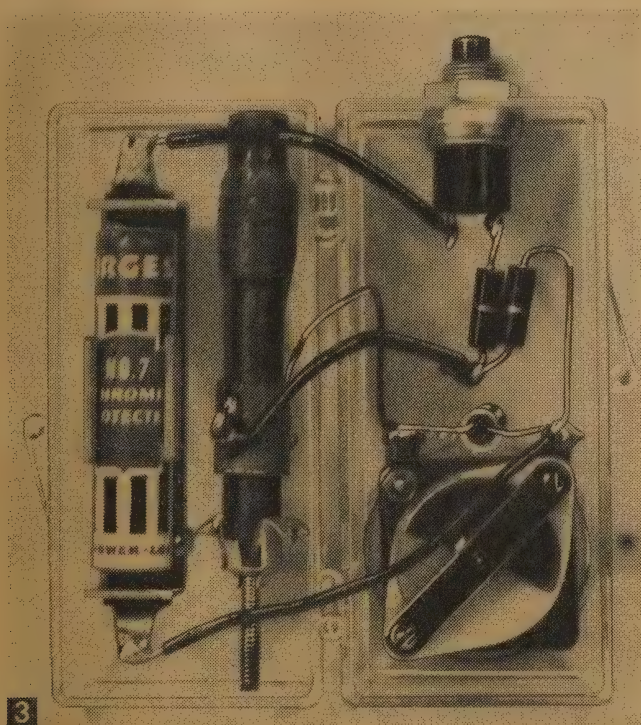
MATERIALS LIST—TUNNEL DIODE OSCILLATOR

Design.	Description
R2	27 ohm, 1/2 watt carbon resistor, 10%
R1	270 ohm, 1/2 watt carbon resistor, 10%
L	broadcast band ferrite loop antenna (Miller 6300)
C	365 mmf. miniature tuning capacitor (Lafayette MS-445)
TD	tunnel diode General Electric 1N2939 (ZJ56) or 1N2940 (ZJ56A)
S	miniature momentary contact switch (Grayhill 4001)
B	1.5 v. penlite cell (Burgess #7)
	penlite cell holder (Lafayette MS-137)
	1 x 1 1/4 x 2 7/8" plastic case (Lafayette MS-157)

Components for this project may be obtained from Lafayette Radio, 100 6th Avenue, New York 13, N. Y.



2 SCHEMATIC



3

Rear view of oscillator with case open.

verse it. The General Electric 1N2939, 1N2940, and 1N2941 (formerly designated as the ZJ-56 series) are housed in TO-18 cases and have the pin connections shown in Fig. 2. Note that leads 1 and 2 are both connected to the positive electrode.

The rear view of the tunnel diode oscillator with case open is shown in Fig. 3. Use Figs. 2 and 3 for guidance in assembling the unit and wiring it.

Four holes are required in the plastic case. Start these holes with a heated ice pick. Capacitor C and the switch S are on the case centerline. The hole for the capacitor is 5/8 in. from the top of the case. The mounting hole for switch S is centered on the bottom side of the front half of the case. Locate the battery holder mounting holes by using the holder, against the back half of the case, as a guide. Enlarge the tuning capacitor and switch mounting holes to 5/16 in. dia. with a taper reamer. Wash the case with soap and water and rinse with clear water to remove fingerprints after all of the holes have been made.

Mount the switch S, the capacitor C and the battery holder. Then wire the circuit. Use a hot, clean soldering iron and rosin core solder to make connections. Minimize the danger of heat damage to the tunnel diode by grasping the leads with needle nose pliers between the tunnel diode case and the connection point during soldering. When wiring is complete, insert the battery in the holder.

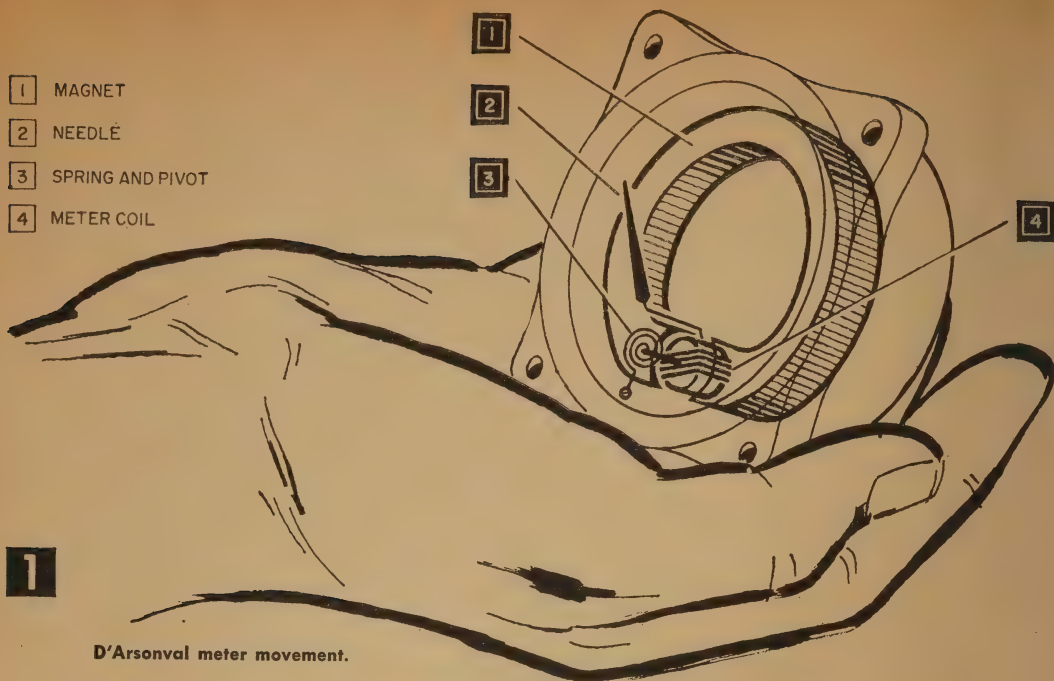
This oscillator operates in the broadcast band. To demonstrate its operation, tune in a relatively weak station on a broadcast receiver. Push the switch S on the oscillator. A momentary contact switch, it is "on" only when depressed. Hold the tunnel diode oscillator near the broadcast receiver antenna and tune C till a whistle is heard. At this point, the tunnel diode oscillator is tuned to the frequency of the received station.

The short length of wire furnished on coil L was removed, but if you have trouble picking up the signal on your receiver, simply connect a 6- to 8-in. length of wire at point A (Fig. 2) and provide a hole for it in the plastic case. This lead will act as a short antenna and provide better coupling of the signal to the receiver.

The unmodulated signal from this oscillator will not be audible in a receiver unless the receiver is tuned to a station. The oscillator signal beats against the received signal.

If you have difficulty check the battery voltage, and check capacitor C for a possible short. Remove the battery and the tunnel diode when checking any portion of the circuit with an ohmmeter. A change in the value of R2 may be required. Disconnect it and substitute a 100-ohm variable resistor. Adjust until unit operates, then disconnect and find value, and permanently install a resistor of this value for R2.—FRANK WOODS, JR.

- 1 MAGNET
- 2 NEEDLE
- 3 SPRING AND PIVOT
- 4 METER COIL



D'Arsonval meter movement.

Meters and Multimeters

By FORREST H. FRANTZ, SR.

THE type of meter we are concerned with has an electromagnetic mechanism known as a d'Arsonval movement. From it I'll show you how to make voltmeters and ammeters and ohmmeters.

How Meters Work. The d'Arsonval meter (Fig. 1) contains a permanent magnet, a coil that is free to rotate about its pivot axis, a needle attached to the coil and a spring that resists displacement of the coil from zero and tends to restore the coil to zero.

The torque that causes the coil to turn is developed when a current passes through the meter coil. The amount is proportional to the current passing through the meter coil. The coil and needle are supported by low friction bearings so that mechanical resistance is low. The pole pieces conduct the flux from the magnet poles and the circular iron core over which the coil rotates. This core and the curved pole piece faces assure that the magnet's flux is always cutting the coil windings at right angles.

The most common basic d'Arsonval meter movement is the 0-to-1 milliamperere dc meter.

Designing Your Own Meter Instruments. Assume for simplicity in the examples, that all of the work is being done with a 0-1 ma. meter. The resistance of the meter, if not

known, can be determined by the circuit of Fig. 2. Adjust pot R, which is connected as a high resistance rheostat, for full scale meter deflection. Connect shunt RS across the meter terminals, and adjust it until the meter deflection is reduced to half scale. The resistance to which RS is adjusted is the resistance of the meter movement. The resistance of RS may be measured with an ohmmeter or Wheatstone bridge.

Once you know the basic movement (I_m) and the resistance (R_m) of the meter, you can increase the current range with a shunt resistance (R_s in Fig. 3.). The value of the shunt resistance for a new range is determined using these formulas:

$$(a) I_s = I - I_m$$

$$(b) R_s = R_m \left(\frac{I_m}{I_s} \right)$$

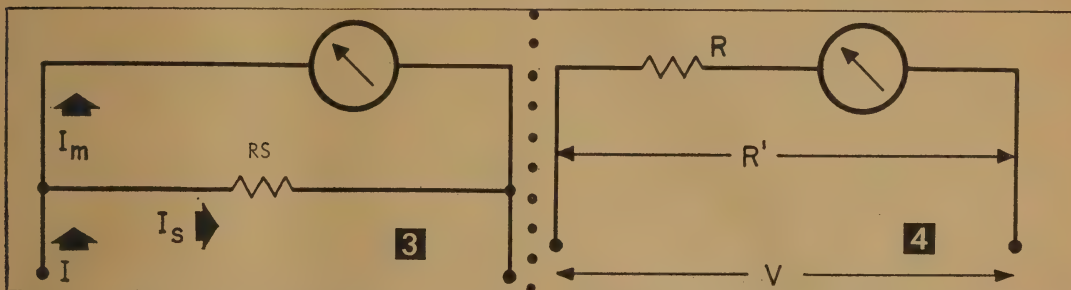
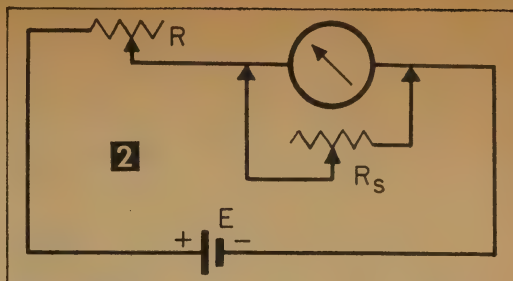
You can buy a 1% shunt resistor, or you can make the shunt by winding insulated resistance or magnet wire on a form, such as a matchstick or a Bakelite bobbin. Or you can use a rheostat, adjust it to the proper resistance, and lock it with a cement seal between the shaft and bushing. Most shunt resistance values will be so low, though, that it's best to wind your own.

In designing an extended-range meter

2 Circuit for measuring meter resistance. With RS out of the circuit adjust R for full-scale meter deflection. Then connect RS across the meter as shown and adjust it till the meter reads half scale. The meter resistance is equal to the value to which R is adjusted.

3 Extending the range of a current meter with a shunt resistance.

4 Converting a milliammeter to a voltmeter with a series resistance.



using a basic meter movement, try to select a range that is a convenient multiple of the meter scale range. Multiples of 10 are best since you can read the meter directly, and have to supply only the decimal point. Two and five are the next best choices for scale number multipliers, and of course, multiples of 10 can be used with these also. (Same applies to voltmeters.)

The circuit for converting a milliammeter to a voltmeter is given in Figure 4. These formulas are used:

$$(a) R' = \left(\frac{V}{I_m} \right)$$

$$(b) R = R' - R_m$$

By connecting a switch (Fig. 5) you can make a multi-range voltmeter.

These current range extensions and voltmeter conversions are solved by applying Ohm's law. In the ammeter application of Fig. 3, the meter and shunt are in parallel. Thus, the voltage across the meter equals the voltage across the shunt. Therefore, the current through the meter times the meter resistance equals current through the shunt times the shunt resistance. And the current into the combination equals shunt plus meter current. The voltmeter arrangement of the second problem (Fig. 4) was based on the idea that the current through the shunt must equal the current through the meter, and the sum of the voltage drops across the meter and the series resistor equals the voltage drop across the combination.

What about measuring resistance with a meter? There are several approaches. The first (Fig. 6) utilizes an ammeter and a voltmeter to measure the current through, and the voltage across, an unknown resistance R_x . Then R_x is calculated from Ohm's law. For

example, if V is 4.5 v and I is .005 amp (5 ma.), using:

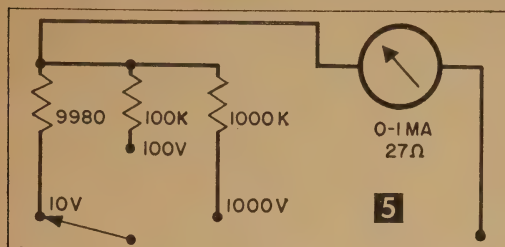
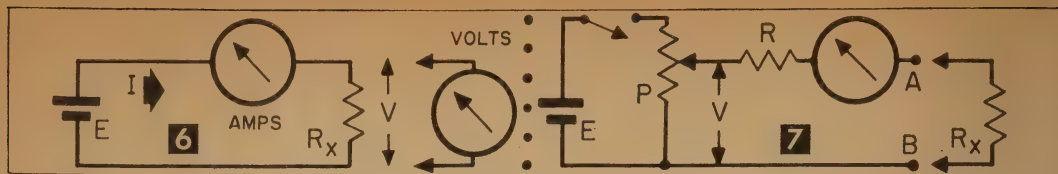
$$R_x = \frac{V}{I}. \text{ Then } R_x = \frac{4.5}{.005}, \text{ and } R_x = 900 \text{ ohms.}$$

This method is cumbersome, so let's see if we can get around it. If we know the voltage E of the battery, do we need to measure V? No, if R_x is much greater than the resistance of the meter measuring the current I. This leads us to the circuit of Fig. 7, where a pot P is employed to adjust the voltage V to a value around which we'll design our ohmmeter. Assuming that we'll use a 1-ma, 27-ohm meter movement, as before, we'll want the resistance of P to be about 500 ohms. This choice is made on the assumption that the current from the battery should be 10 or more times the current through the meter, for accurate results. The resistance across A and B is zero, if we short these terminals. Therefore the resistance of R and the meter should be 5v (the design voltage) divided by the meter current, .001 amp. Resistance R, therefore, is 5000 ohms, minus the meter resistance of 27 ohms, or 4973 ohms. Since 5000 and 4973 ohms differ by only about $\frac{1}{2}\%$, you can let R equal 5000 ohms without noticeable error. The ohms scale may be calculated in terms of the I scale on the meter by assuming different values of R_x using this formula:

$$I = \frac{V}{R + R_x}$$

Thus, R_x in ohms I in ma.

0	1.000
500	0.909
1000	0.832
2000	0.715
3000	0.625
4000	0.555
5000	0.500



5 A simple 3-range voltmeter. Resistance values were obtained by the method of Fig. 4 and rounded off to practical values.

6 Determining resistance by the volt-current (Ohm's law) method.

7 A simple ohmmeter circuit. In the example in the text, P is 500 ohms. For less critical zero adjustment, substitute (for P) a 100-ohm pot in series with a 400-ohm resistor.

8000	0.384
10,000	0.333
15,000	0.250
20,000	0.200
30,000	0.143
50,000	0.091
100,000	0.048
200,000	0.024

You can compute additional values yourself. Note that the half-scale meter deflection is equal to R for any meter combination which uses this arrangement. That's a handy piece of information for estimates, before you begin design. The ohm readings may be obtained using a table such as that above, or an ohms scale may be pasted on the meter glass. The switch S is turned on only when the ohmmeter is being used.

The potentiometer P may be made up of a 100-ohm pot in series with a 400-ohm, fixed resistance. This arrangement makes the zero resistance adjustment less critical. You can double battery life by doubling the value of P (use a 200-ohm pot and an 800-ohm resistance) with a decrease in accuracy that's negligible.

To convert a basic dc meter movement for ac measurements, rectifiers are used. Their difference in forward and back resistance is so great that we generally assume a rectifier acts as a switch. The rectifier circuit of Fig. 8A, not often used with meters, conducts during only half the ac input cycle. The full-wave half bridge of 8B passes current during all of the input cycle. A 2.7K resistor for each R works well with most germanium diodes. The output current is about 0.72 times the input current. The full bridge of Fig. 8C passes current during the entire input cycle also, but presents a greater output for a given input current. The output current is 0.9 times the input current.

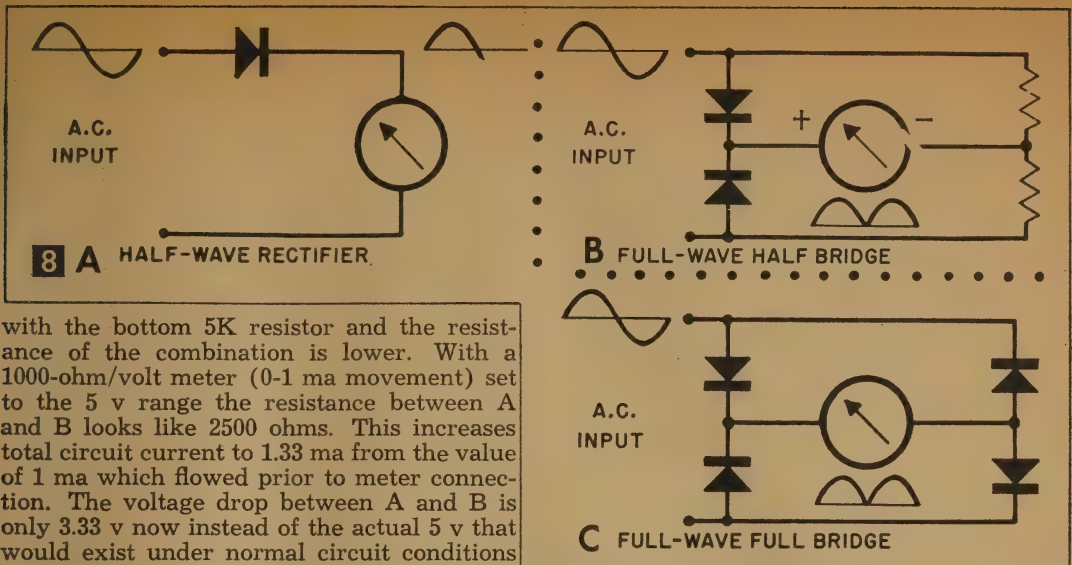
The rectifiers may be germanium diodes or copper oxide types. Germanium diodes are more readily available and cover a broader range of frequencies. The GE 1N64, Sylvania

IN34A and the Raytheon IN66 are suitable.

The shunt resistances for current meters and the series resistances for voltmeters of the ac variety may be determined in the same way as they were determined for dc instruments, but bear in mind that the transfer factor of the rectifier arrangement alters the value of the ac voltage required for full scale deflection, and that the apparent meter resistance is changed, too. Use the circuit of Fig. 2 for experimentation, considering the rectifier input terminals as the meter terminals and an ac voltage source instead of a battery to determine the apparent meter resistance. The current through the meter is the voltage across R divided by the resistance of R. Then, the formulas of Fig. 3 and 4 can be applied.

Multimeters. There are many meter kits available at low prices. They're called VOM (volt-ohm-milliammeter) or multimeter kits and are good for measuring ac and dc current and voltage, and for measuring resistance. Although many factors enter into the choice of a meter kit, the primary consideration is meter sensitivity: the number of ohms resistance that the meter movement and the series resistance present between the input terminals of the meter, divided by the corresponding voltage range. This is expressed in ohms/volt. This number is a function of meter movement current for full scale deflection. A 1-ma meter has a sensitivity of 1000-ohms/volt; a 200 microamp. meter has a sensitivity of 5000 ohms/volt; and a 50 microamp. meter has a sensitivity of 20,000-ohms/volt.

The sensitivity is important, because when you connect a voltmeter into a circuit to make a measurement, you're connecting a resistance across the circuit. If you connect too low a resistance across the circuit, you'll draw enough current from the circuit to get a wrong voltage reading. Figure 9 illustrates what can happen. When you connect the meter across AB, its resistance is in parallel



Meter rectifier circuits.

with the bottom 5K resistor and the resistance of the combination is lower. With a 1000-ohm/volt meter (0-1 ma movement) set to the 5 v range the resistance between A and B looks like 2500 ohms. This increases total circuit current to 1.33 ma from the value of 1 ma which flowed prior to meter connection. The voltage drop between A and B is only 3.33 v now instead of the actual 5 v that would exist under normal circuit conditions—a big error. However, if a 20,000 ohm/volt meter were used to make the measurement, the resistance paralleling R2 would be 100,000 ohms on the 5-v range, and the resistance between AB would be 4760 ohms. The total current through the circuit would be 1.023 ma, and the voltage between A and B would be 4.87 volts, very close to exact.

Using a Multimeter. My young son uses his meter to check the resistance of a toy motor. If it's open, the needle reads infinite resistance (no deflection). Sometimes he checks his toy motors by using them as generators, switching the meter to a low dc voltage or current range and looking for a meter deflection as he rotates the motor shaft.

The motor used as a generator with a meter indicating output voltage across or current through a resistance makes a good rpm indicator for lathes, drills, motors and engines (including cars). The same scheme may be used for a speedometer for bicycles or a child's wagon. Equipped with a propeller or vane that is outfitted to face into the wind or equipped with anemometer type cups, this same electrical arrangement may be used to measure wind speed. The hook-up of Fig. 10 may be used for any of these applications. The size of the series rheostat must be determined experimentally and may include a series resistance in the meter if you use the dc voltage range of a VOM for the meter. A more versatile approach is to use a dc current range.

Usually the pot adjustment can be made to calibrate the meter so the existing meter scale with a suitable fraction or multiple of 10 will provide the desired range of rpm or mph. Sometimes, though, you'll have to provide a paper and ink scale, and you'll have to figure out the mechanical coupling.

A multitester's ac volts range can be used

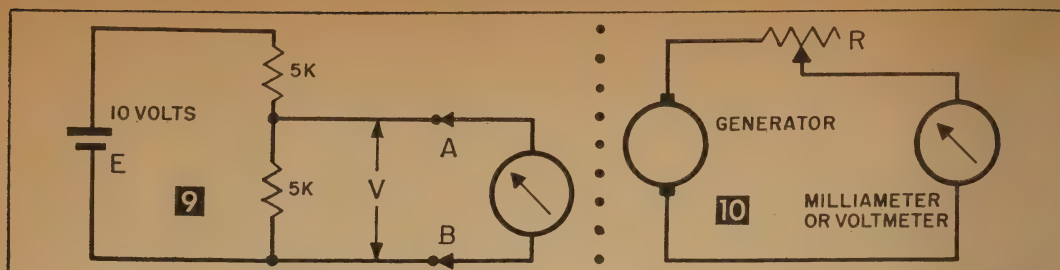
with an audio amplifier to produce an audio millivoltmeter, a sound survey meter or an applause meter (Fig. 11A). Figure 11B shows resistance-capacitance meter coupling, and 11C shows transformer coupling to the meter. You can rig up a calibration template for the amplifier volume control so you can use it as you'd use a range switch. You can use the meter's decibel or voltage scales.

The ac voltmeter ranges may be used to measure capacitance of paper, oil or mica dielectric capacitors. Use the circuit arrangement of Fig. 12. Adjust the pot till the voltages at A and B are equal. Then disconnect the pot and measure its resistance R. For the capacitance in microfarads, substitute the value of R in this formula:

$$C = \frac{1,000,000}{377R}$$

This circuit works best with higher ac voltages, but 30 v is the top, safe limit. (The voltages across C and R won't add up to the applied voltage.) Get the 60-cycle ac voltage from a transformer—either a filament transformer or a train transformer will do. And, don't use this arrangement to measure low-voltage electrolytic capacitors, or you may ruin them! You can use a 6.3-v transformer in the circuit to test electrolytic capacitors rated 100 v or more, without damage.

Beginners can use a meter to get a good understanding of electricity. Use it to find out: What happens when you connect batteries in series and parallel; what happens to the battery voltage when you decrease the resistance connected to it; what happens to the voltage and current when resistors are connected in series or parallel; how to apply



Ohm's law; the difference in the resistance of a light bulb before it's turned on and after it has been on a while. Incidentally, never use the ohms scales to measure resistance in a circuit under power. Always disconnect the voltage from the circuit before you measure resistance.

The resistance ranges may be used to check light bulbs and lamp wiring. If the ohmmeter needle deflects at all on the low ohm range, the bulb (or lamp wiring with a good bulb in the lamp and the switch on) isn't open and if the meter needle doesn't hit zero, the bulb or lamp isn't shorted. In the case of a table or floor lamp, if you get this kind of indication, everything's good, except that you're not sure that the switch will work. When you turn the switch off, the meter needle will return to its normal rest position if the switch is operating properly. This is the technique for trouble-shooting radios, electrical appliances and home and car electrical wiring.

Another example of the continuity check just outlined is locating tubes with open heaters in a radio or TV. If none of the tubes in an ac-dc (transformerless) radio light up when the radio is on, the probable cause of trouble is an open tube heater. An open tube heater will also cause a TV set to be inoperative, but won't necessarily prevent all tubes from lighting up. To check tube filaments for

9 Illustrating how a low sensitivity voltmeter upsets low current circuit operation and gives false readings (see text).

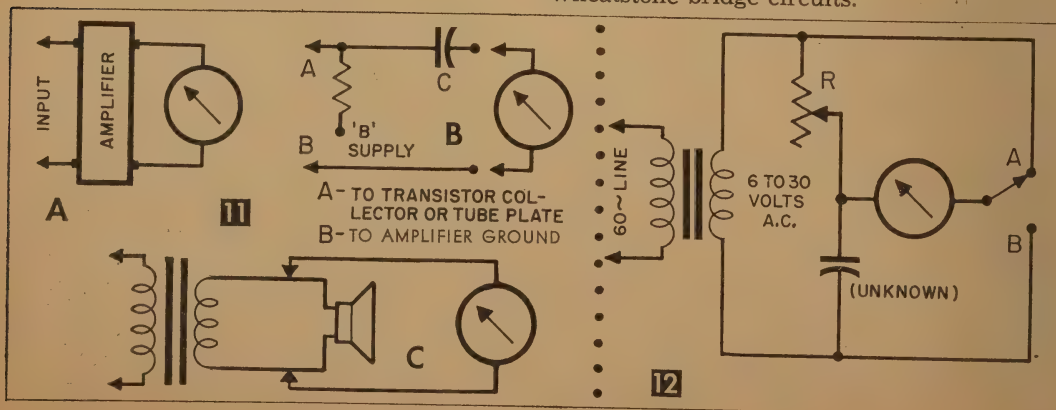
10 A toy motor used as a generator in this simple circuit has many practical uses. Determine R experimentally.

opens, use the ohmmeter test leads across the heater pins (power disconnected). The pin numbers may be obtained from tube manuals.

An ac voltmeter is useful in checking ac line voltages, transformers, circuit wiring, oscillator output, model railroad and toy circuits and for numerous other applications. The dc voltmeter is useful in checking batteries (check them for voltage with the normal load connected), checking dc power supplies, trouble-shooting in radios and car wiring, and for numerous other applications. You should have little difficulty in voltage measurement.

Current measurements are not used as commonly in routine trouble-shooting and experimenting, but are becoming more important with the advent of the transistor. The important thing to remember in making dc current measurements is that the meter is connected in series with source and load. That is, one of the leads connects to the source of voltage and the corresponding connecting point on the device that is receiving power. You might look at it as simply cutting one of the leads in the circuit and connecting the current meter to the lead ends that you've created. The microampere range on the meter is also useful as a current detector in Wheatstone bridge circuits.

|| Using an amplifier with an ac voltmeter as an audio millivoltmeter, sound survey meter or an applause meter (a); R-C coupling meter to amplifier (b); and meter-connected amplifier output transformer (c).



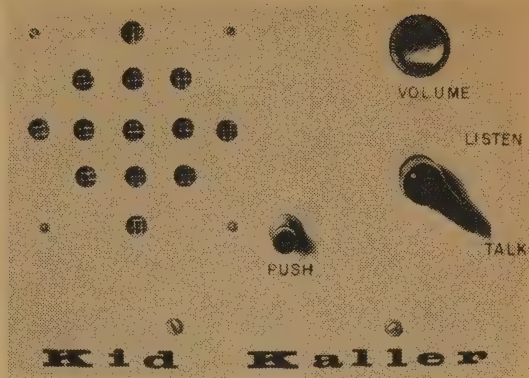
Kid Kaller

By HOMER L. DAVIDSON

WHEN the children are out playing, they can never be found when wanted. With this unit, however, simply by pushing in on a push-button switch you can call them. And then you can hear their reply or listen in on the outdoor happenings.

A DPDT two-position is used to switch from Talk to Listen position. A SPST switch of the momentary-hold type shuts the unit off. By using this type of a switch the battery will be on only when pushed, and outside noise will be present only when listening. The unit responds at once when pushed on, since there are no tubes to warm up.

Circuit Description. This inter-

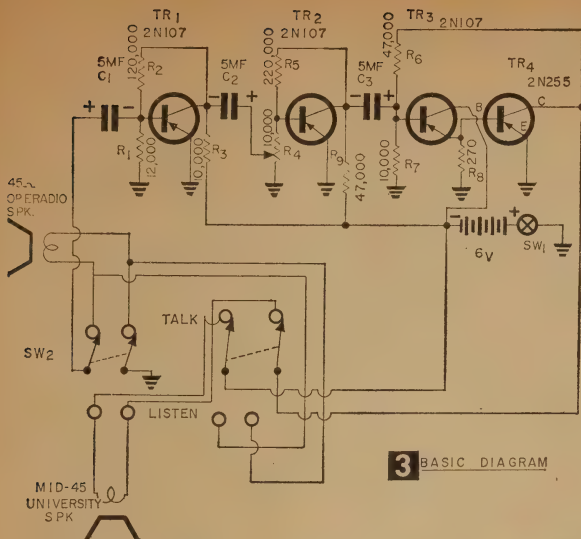


Kid Kaller can be installed in kitchen cabinet, as here, for instant communication outdoors.

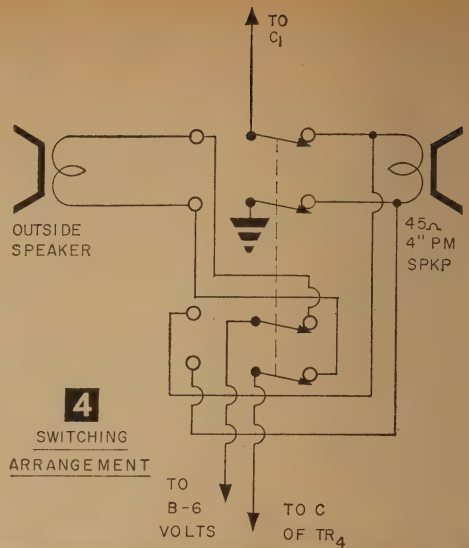
Outside speaker can be located near back door, on post in yard or on garage.



com caller is built around four transistors. The first three are 2N107—PNP low-cost types. A 2N255 CBS power transistor is used in the output circuit for greater volume. From the input of the house unit a 45-ohm voice coil permanent magnet speaker is placed in the base circuit of the first cascade stage. This speaker, used as a microphone, is coupled to the base circuit through a 5 mfd electrolytic capacitor. The signal is amplified, then capacitively coupled to the second transistor stage through a small volume control that controls the output volume. Both emitters of the first two stages are grounded. A base resistor is tied to each collector terminal.

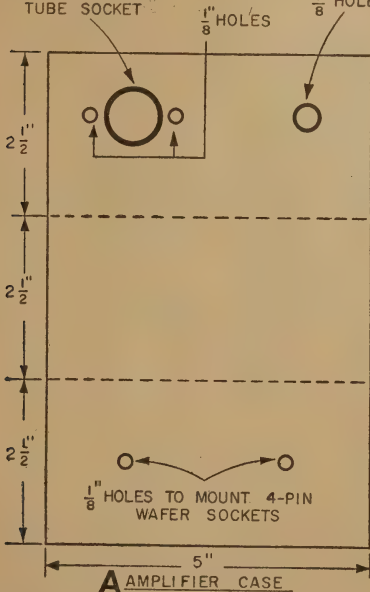


3 BASIC DIAGRAM

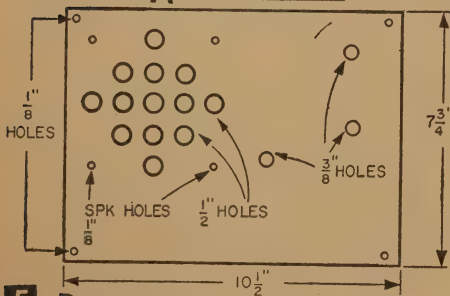


4 SWITCHING ARRANGEMENT

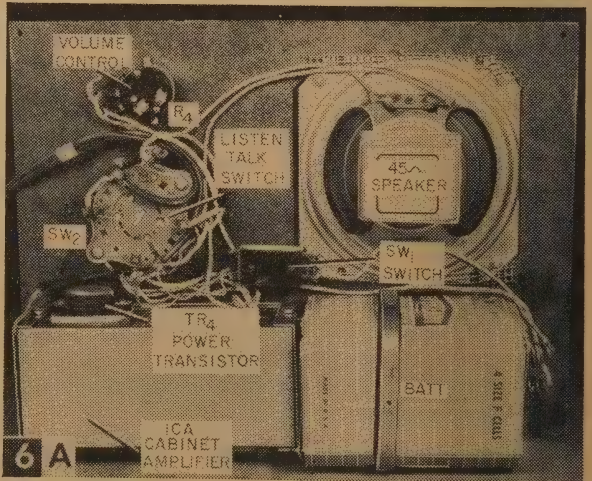
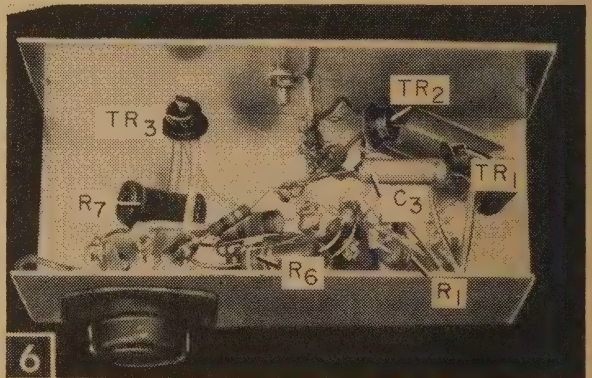
HOLE FOR 9-PIN TUBE SOCKET



A AMPLIFIER CASE



5 B FRONT PANEL



Amplifier and its case (6) and back view of complete unit (6A), except for outside speaker.

In the third audio stage the collector is tied directly to the battery, while the emitter terminal is wired directly to the base circuit of the power transistor. The base return

resistor is tied to the collector circuit of the power transistor. A 45-ohm, paging type speaker is switched into the output of the 2N255 collector circuit. As the output

MATERIALS LIST—KID KALLER

Desig.	Description
C1, C2, C3	5 mfd miniature elect. capacitors
R1	12,000-ohm, 1/2-watt carbon resistor
R2	120,000-ohm, 1/2-watt carbon resistor
R3, R7	10,000-ohm, 1/2-watt carbon resistor
R4	10,000-ohm I.R.C. volume control
R5	220,000-ohm, 1/2-watt carbon resistor
R6, R9	47,000-ohm, 1/2-watt carbon resistor
R8	270-ohm, 1/2-watt carbon resistor
TR1, TR2, TR3	2N107 GE transistors
TR4	2N255 CBS power transistor
SW1	SPST hold-type push switch
SW2	Rotary DPDT two-position switch
	Operadio 45-ohm 4" PM spkr. (microphone)
	Mid-45 University paging-type spkr. (outside)
	6-volt battery, lantern type

impedance of the power transistor is around 48 ohms, this insures a perfect match for amplification.

There will be no need for an output transformer in this type of circuit. The power or voltage to be applied to the circuit is furnished by a heavy duty lantern battery. Since the unit is used only intermittently, the battery lasts a long time.

Construction. Construct the amplifier inside an ICA aluminum case (see Materials List), or make your case, as shown in Fig. 5A, from thin-gage aluminum. Mount all 2N107 transistors directly on a three-lug terminal strip; the power transistor, in a standard 9-pin miniature socket insulated from the metal chassis (see Fig. 6A). There is no need to construct a heat sink for the power transistor since the unit is not on long enough to get warm.

Cut the front panel from hard-tempered Masonite and drill necessary holes before painting (see Fig. 5B). I used a white enamel spray paint so that the small unit would match the kitchen walls. The wire lead to the outside speaker can go directly through the wall through a small hole. Place colored putty around the hole so there will be no danger of weather damage.

Fasten the amplifier unit to the front panel with four small bolts and nuts and secure the PM speaker to the panel also. Mount the double wafer switch directly above the amplifier chassis (see Fig. 6A). A small metal bracket was constructed from aluminum stock to hold the lantern battery to the front panel. The switching circuit is shown in Fig. 4.

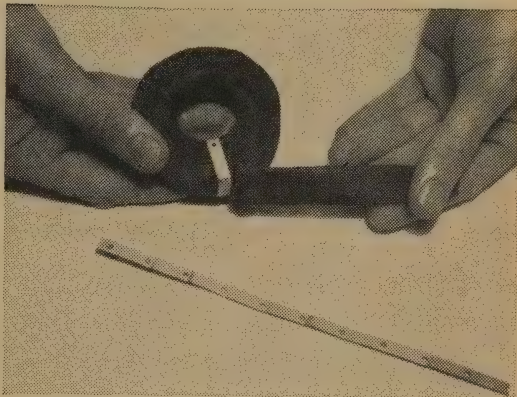
Operation. When the wiring has been completed and the unit installed, except for the outside speaker (which should be wired into circuit but not secured outside), push down on the switch and—with volume half-way up—feedback should occur between outside speaker and microphone speaker.

Then turn the switch to listen position and press the switch again. Again feedback should occur. If it does not, check the wiring of the double wafer switch. Now place the outside

speaker outdoors so that feedback will *not* occur with someone talking into the microphone speaker.

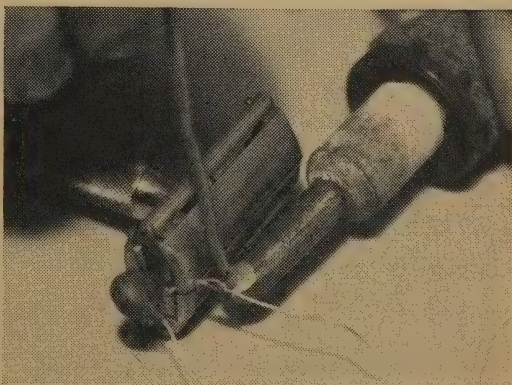
There are many uses for this small unit. The caller can be used as a regular intercom simply by placing a switch on the back of the volume control. Or the outside speaker can be placed on a post in the farm yard so the housewife can speak to her husband outside. Or you may be a rabid bird watcher. The outside speaker can be placed near a bird house and you can hear them while watching them.

Tape Cut-Off



- Rolls of plastic, rubber, and friction electrician's tape have no cutting blade to cut strips to length. A piece of metal cut-off blade removed from a wax paper box makes a good cutting edge. Simply cut off a length of blade that will fit loosely around the roll, overlap it on the inside and solder.—JOHN A. COMSTOCK.

Razor Shunts Iron Heat



- That discarded razor can serve a useful purpose as a heat shunt when soldering radio parts leads. Clamp the razor over the lead and it will absorb the soldering heat that might otherwise damage or change the value of the radio part.

The Hidden DX

Here's something new in DX —

tuning FM subcarriers

By C. M. STANBURY II



The experimenter's DX special for hidden DX, consisting of a Hammarlund HQ 120 X and a Granco 780. Almost any combination of short-wave and FM receivers will do, but it is better if the SW set is equipped with band spread.

DO YOU own an FM receiver? Chances are pretty good you do, or could, because there are sets in the stores selling for as little as \$29.95. Second question, are you a DXer? If you are, then you're missing one tremendous bet on the FM band.

We're crazy? FM DX is a cross between that found on the Broadcast Band and VHF TV channels. However, DX listeners are missing some very rare catches between 88 and 108 mc, loggings which compare with the most unusual to be found anywhere in the radio spectrum. Hidden on the band are signals which the ordinary FM receiver will never pick up, which even local listeners will probably never hear. But if you have a short-wave receiver, you can. And at a distance, Rare enough for you?

Most of our readers will be familiar with one class of station in this "hidden" group, the satellites on 108 mc, but unless you have special equipment, these require a tremendous amount of patience. A much more inviting target are the *subcarriers* used for background music and storecasting. Believe it or not, such signals you will be able to detect (for DX purposes only), log and QSL with only a reasonable amount of effort.

How's it done? By using AM detection instead of FM. An FM detector measures the deviation between the frequency transmitted and the carrier frequency, subtracts them, and the result is an audio frequency. We have taken WSOM as an example, carrier frequency 105100 kc (105.1 mc). If the signal deviated to 105101 (or 105099) the result would be a 1 kc or 1000 cps audio note. However, should the deviation exceed 15 kc, it

would produce a supersonic audio note which your audio circuits would reject, no speaker could reproduce, and of course you couldn't hear it anyway. Thus WSOM may transmit background music around 105167 (the subcarrier) and no ordinary FM set could ever receive it.

But an AM receiver (detector) responds to

variations in amplitude, and in this sense, not to frequency deviation. The subcarrier does produce amplitude variations. Thus if you could tune an AM receiver to 105167 it would pick up WSOM's subcarrier. The sounds would not be enjoyable listening but recognizable as music, and—more important from a DX standpoint—loggable.

But you don't have an AM receiver that will tune the FM band? You don't need one, the FM set will do it for you. Double talk? No.

An FM set receives a signal from the antenna, passes it through one stage of RF amplification (a few have two) then feeds it into a mixer tube where it's converted to an intermediate frequency, the most common of

QSL's received—

"Dear Mr. Stanbury:

"Thank you for your report on reception of WRRA located on Connecticut Hill, 9 miles southwest of Ithaca, New York.

"The subcarrier you detected was our 67 kc multiplex subcarrier for background music . . .

"You may . . . be able to detect bursts of high frequency tone (19 kc to 29 kc) at station identification time and also our 45 kc telemetering frequency at odd intervals."

Northeast Radio Corporation

* * *

"Dear Mr. Stanbury:

"This will acknowledge your letter of 7 August 1959, relative to reception of radio signals from the Discoverer Satellite.

"Time, frequency and emission would certainly indicate that the signals you received were from the Satellite . . ."

From a Government Agency

CONFIRMING RECEPTION of	
the SUBCARRIER of	
MEM SALEM, OHIO	
KC/S 105167	DATE December 18, 1959
BY <i>A. S. Hawk</i> <i>A. Eng</i> <i>Thanks</i>	

QSL for an FM subcarrier. The card was prepared by the author to expedite verification.

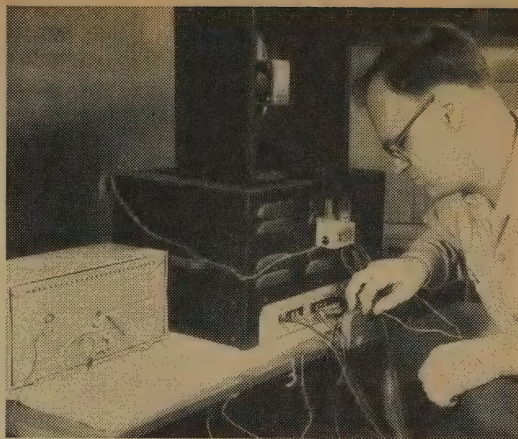
which is 10.7 mc. So far, simple. But what you may not know is that the mixer tube radiates a small portion of the signal at the IF frequency. Such radiation passes back into the antenna circuit. If a shortwave receiver is hooked up to the same antenna, there will be no difficulty picking up the FM signal at 10.7 mc (or whatever the IF is). Once you pick it up on your shortwave receiver, you will of course be using that all-important AM detection.

Now that we've reached the antenna, let's consider it a moment. Subcarriers usually produce weak signals. Thus your antenna must receive signals well from that direction. Which direction? Well, that depends upon which DX station you're after. In other words, your antenna must function in *all* directions. The best solution is a rotor, the kind used for TV antennas. But if you don't already have one, this is also the most expensive. A compromise would be the old fashioned long-wire.

Which brings us to a second use for the hidden-DX receivers: That very tough space reception. Most American satellites use either A1 (on/off) or F1 (frequency shift, in this case producing beep effect) modulation to identify their carriers. Both can be received much better on the narrow band set-up described here than on an ordinary broad-band FM receiver.

Now that the equipment is set, you're ready to use it. The first step would be to listen to one or more of your local FM stations so you become familiar with their sound when detected via AM. If you know one of them has a subcarrier, listen to it (look for a subcarrier when the orthodox programming is other than music). Among other things you will note that mixed with the background music will be transmissions from the standard carrier.

Finding a Subcarrier. The process is the same for both local and DX stations. Tune in the stations as well as possible on your FM set, then turn the volume down to nil (but not off). If your shortwave receiver is equipped with band spread, place it at the maximum



No internal adjustments are required on the rig, only a common antenna.

setting and find the carrier frequency on the main dial (around 10.7 mc or whatever the FM IF is). The carrier will be at the point of peak signal, but it can be found much more accurately by waiting for a moment of dead air (even while the announcer takes a breath). It will then appear as a distinctive hum at just one frequency. (In actual practice this extremely fine tuning is accomplished by a slight adjustment of the bandspread.) Once you find the carrier, look for the subcarrier with the bandspread. Assuming the station has a strong signal, if you fail to find it after a couple tries, place the bandspread at its lowest reading, retune the carrier via the main dial and start searching for your quarry again. If you don't have bandspread, tune in the standard carrier, note the frequency reading carefully, then tune back and forth for the subcarrier. When you find it, note that dial setting also.

Although these procedures sound complicated, they will—with a little practice—become simple routine and in the long run prove much easier than any haphazard approach.

Except for identification, which will be obtained from the normal FM transmission, you'll have to garner enough information from the subcarrier to authenticate reception of same. First item is frequency. If the subcarrier appears above the carrier on your shortwave receiver, it will actually be below it and vice versa. However the indicated frequency difference will be correct. Such readings should be as accurate as possible. A bandspread may be calculated via 31-meter SWBC images or more easily by using a 100 kc crystal calibrator. For space reception, pinpoint accuracy is absolutely indispensable.

Other verification data might include timing between records (to the second) and possibly song titles, although many stations keep no record of the latter, so don't depend upon it.



A speaker connected to the Hi-Qual Pre-Amp input can function as a mike sensitive enough to record heart beats.

Hi-Qual Pre-Amp

This preamp is inexpensive, easy to construct. It has a gain of about 500 flat from 10 cycles to 20,000 cycles. It may be used in apparatus requiring a quality pre-amplifier circuit, or as a laboratory tool

THE electronics and scientific experimenter frequently needs a high quality preamplifier. The preamp must have a low value of internal noise, hum, and hiss. It should have a reasonably high input impedance, high gain, and the gain should be relatively independent of the power supply voltage. The frequency response should be relatively flat over a wide range of frequencies, and distortion should be low.

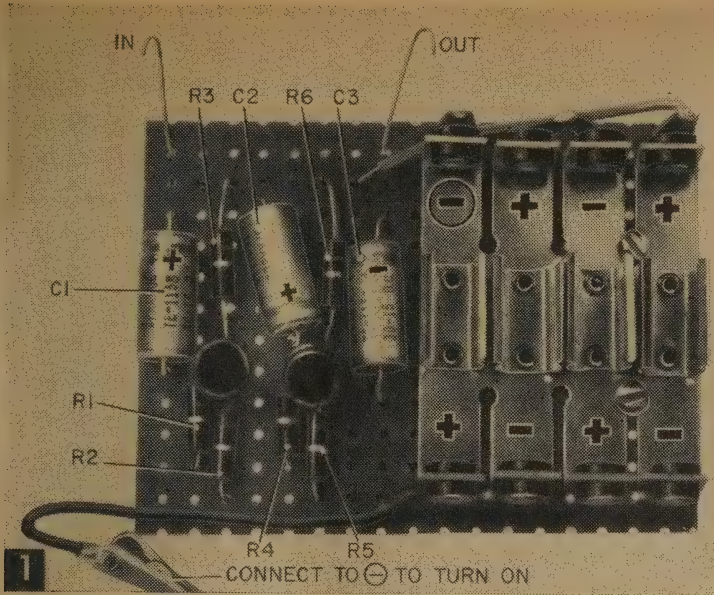
An amplifier that meets these specifications may be used as a phonograph, microphone, or tape recorder pick-up preamplifier. It may be used with a crystal detector tuner to drive a power amplifier for hi-fi listening. As a lab preamp a unit meeting the outlined specs can be used to detect small ac voltages, as a meter amplifier for a conventional meter, as a preamp for older, less sensitive oscilloscopes, and for a host of other uses.

The Hi-Qual Pre-Amp meets the specifications outlined, and it can perform the jobs outlined, plus numerous others. In addition to the characteristics mentioned below the title of this article, it is: 1) transistorized—uses two high gain GE 2N508 transistors; 2) dc operated from 6 v—no line cords to get in your way; 3) battery economy is good—requires less than 2 ma; 4) stabilized for variations in transistor characteristics and temperature; 5) handles inputs from zero to 3 millivolts with minimum distortion. The range may be extended by connecting a volume control in the input circuit (Fig. 4); 3 millivolts input produces a 1.5 v output; 6) input impedance is greater than 10,000 ohms; 7) compact construction— $\frac{3}{4} \times 2\frac{1}{16} \times 3\frac{3}{8}$ in. including self-contained battery (Figs. 1 and 2); 8) simple construction—can be built in about an hour with minimum chances of wiring mistakes; 9) flexible—can be built into other equipment or as a separate lab instrument and can be modified to meet varying requirements.

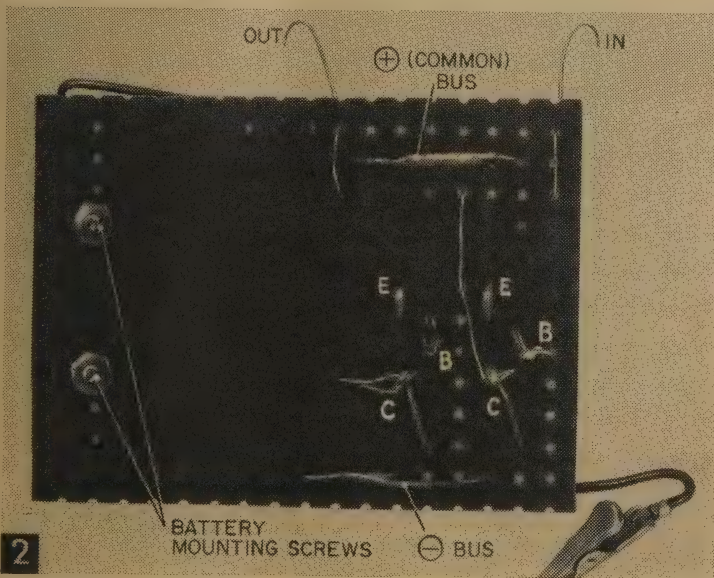
Construction. The top and bottom views of the completed amplifier are shown in Figs. 1 and 2; the circuit diagram is shown in Fig. 3. Using these as a guide, proceed as follows:

1) Drill two $\frac{1}{8}$ -in. dia. holes in the perforated board for the battery holder. There are four small perforations left between these two holes, and the two holes line up on the second row of perforations. Mount the battery holder and connect the terminals for series connection of the batteries. This is accomplished by turning the battery holder lugs till they contact each other, then soldering them together. Fill the inside eyelets of the battery holders which will contact the batteries with solder. This will minimize the chance of poor-contact or no-contact problems later.

2) Insert the transistor, resistor, and capacitor pigtailed through the appropriate board perforations. Note that one pigtail of R2 and



Top view of Pre-Amp.



Bottom view of Pre-Amp.

the collector pigtail of T1 both pass through the same perforation. The same applies to R1 and base T1; R3 and emitter T1. This also occurs for similar elements of T2 and the counterpart resistors. Be careful to position the capacitors with polarities as shown in Fig. 1.

3) The instructions which follow refer to connections made on the bottom side of the perforated board. Connect C1 (-) to junction R1-base T1. Solder and clip off the extra lead length.

4) Connect free end R1 and C2 (-) to collector T1. Solder and clip off extra lead length.

5) Solder R3 and T1 emitter junction; clip off extra lead length.

6) Connect free end C2 (+) to junction R4 and T2 base. Solder and clip excess.

7) Connect free end R4 and C3 (-) to junction R5 and T2 collector.

8) Solder junction R6 and T2 emitter; clip excess lead.

9) Bend free R3 and R6 pigtails against board and solder. Connect a 2-in. length of wire from this junction to the (+) battery holder terminal.

10) Bend free pigtails of R2 and R5 against the board and solder. Connect a 3-in. length of wire to this junction. Solder a Mueller Mini-gator clip to the other end of this wire. The clip is the On-Off switch for the amplifier. To turn the amplifier on, fasten the clip to the (-) battery holder terminal.

The clip lead switch may be replaced with a more sophisticated switch, but this isn't feasible unless the amplifier is housed in a case which has mounting space. The case may be the case which encloses another piece of equipment of which you want to make the preamp a permanent part, or the amplifier may be housed in its own case. The Lafayette MS-159 plastic case is a good fit, and there's room for a switch or control with switch.

The (+) pigtails of C1 and C3 are the "high" input-output terminals of the amplifier respectively. The

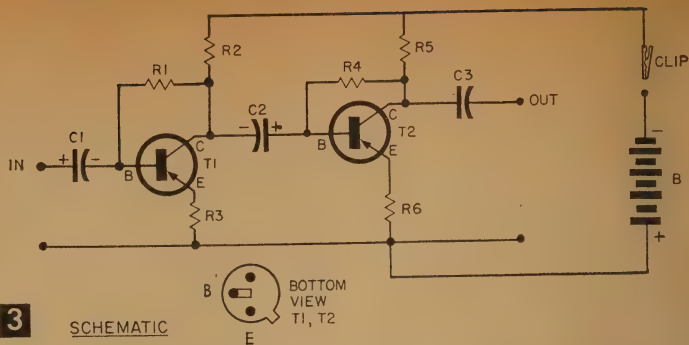
junction of R3 and R6 is the "low" common terminal for input and output. A lead may be soldered at this point for connection purposes. Minigator clips may be attached to these input-output leads, or other terminals of the user's choice may be provided.

A volume control or volume control with switch may be connected at the input of the amplifier as shown in Fig. 4. The amplifier will begin to distort when the input level exceeds 3 millivolts. The volume control divides higher voltage levels and can be set within

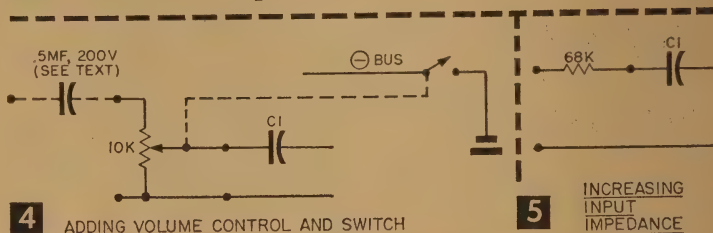
the amplifier input limits. The Lafayette VC-28 miniature control (10K with switch) is suitable for this application and will fit in the plastic case mentioned previously. The 0.5 mfd, 200 v capacitor shown in Fig. 4 should be used if the input signal contains a dc component.

However, if the dc voltage involved is greater than 200, a capacitor with a larger voltage rating must be used.

The input impedance of this high-quality pre-amplifier may be increased by connecting a 68,000-ohm resistor in series with the pre-amplifier's high input lead as shown in Fig. 5. This increases the unit's input impedance to approximately



3 SCHEMATIC



4 ADDING VOLUME CONTROL AND SWITCH

5 INCREASING INPUT IMPEDANCE

MATERIALS LIST—HI-QUAL PRE-AMP

Design.	Description
R6	10 ohm, 1/2 watt, 20% carbon resistor
R3	100 ohm, 1/2 watt, 20% carbon resistor
R2, R5	2.7K, 1/2 watt, 20% carbon resistor
R1, R4	680K, 1/2 watt, 20% carbon resistor
C1, C3	30 mfd, 15 v miniature electrolytic
C2	capacitor (Sprague TE-1158)
T1, T2	2N508 transistor (General Electric)
B	four 1.5 v penlite cells (RCA VS0-74)
	battery holder (Lafayette MS-170)
	27/16 x 33/8" miniature perforated board (Lafayette MS-304)
	Minigator clip (Mueller 30)

80,000 ohms (80K), adequate for most high-impedance sources. Of course, this results in a reduction of gain to approximately 1/8th of the previous 500 value.

As happens so often as to establish itself as a general rule, conflicting objectives of high voltage gain and high input impedance in transistor amplifiers must be accepted as a fact of life.

The preamp may be used as an amplifier for any reasonably sensitive low-voltage alternating-current meter or the low alternating-current range of a multimeter (Fig. 6). The Heathkit MM-1 Multimeter has a low range of 1.5 v which is ideally suited to this amplifier.

Meters with low ranges greater than that of Heath's MM-1 Multimeter may be used with the amplifier by using the scale only up to 1.5 v.

The preamp output may of course be used to drive an earphone or a power amplifier. The earphone arrangement might be used

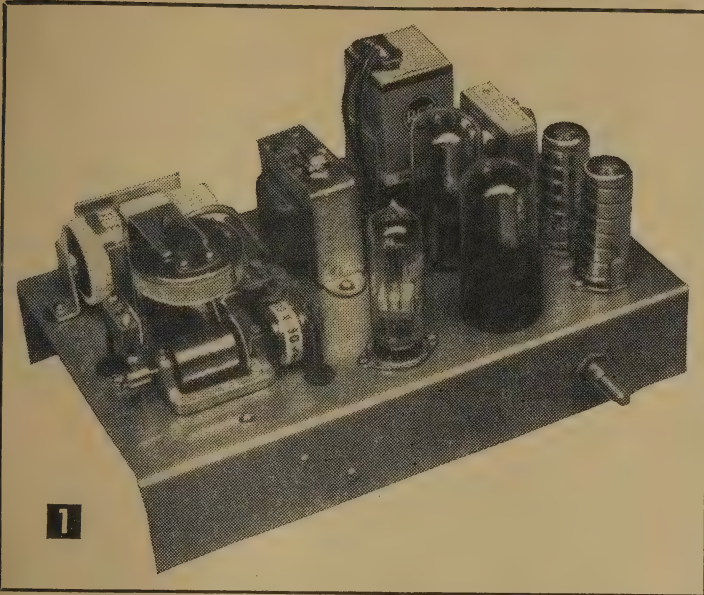


6 Hi-Qual Pre-Amp can be used with ac voltmeter to measure ac millivolts.

with the amplifier for signal tracing or it might be used in conjunction with a crystal radio input.

Another, but not quite so obvious application of the preamp capitalizes on the distortion created by overdriving. If a signal of 0.1 to 0.2 v is applied to the amplifier input, the output waveform will be clipped and will approach a square wave.—FORREST H. FRANTZ, SR.

A Musical Annunciator



With this device hooked into your front door-bell circuit, you substitute the soft, tinkling tones of a music box for the jangle of bell, rasp of buzzer or raucous cling-clang! of chimes

By HARTLAND B. SMITH, W8VVD

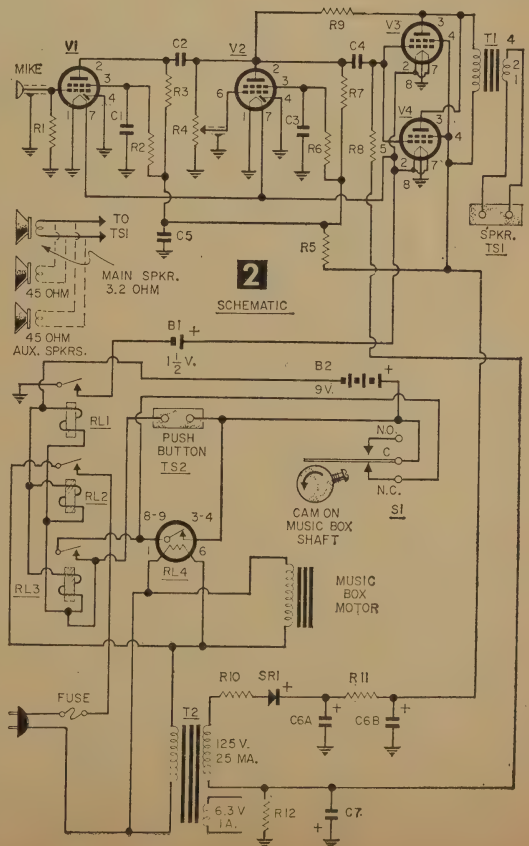
An electronically amplified Swiss musical movement (at left front) makes a pleasant door annunciator.

THE heart of this annunciator is its Swiss musical movement. Powered by a miniature 110-v, shaded-pole motor, this movement will play a 20-second excerpt from one of your favorite melodies. (The available tunes range from *Adeste Fideles* to the *Third Man Theme*, so you should have little difficulty in finding a composition to suit your taste.)

If this tiny music maker is to be heard throughout your home, however, some form of amplification must be employed—and the amplifier must be ready to operate the instant the front door button is pressed.

For economy's sake, no power should be drawn by the unit during standby periods. Consequently, heater-type vacuum tubes cannot be used. The choice, therefore, lies between battery tubes and transistors. Despite continued transistor price reductions, the capacitors, transformers, etc. needed for transistor circuitry are still relatively expensive. In contrast, the parts required for a vacuum-tube amplifier are quite reasonable and, in addition, many are likely to be found in the average experimenter's junk box. For this reason, the unit shown in Fig. 1 utilizes filament-type tubes rather than transistors.

An inexpensive high-output crystal lapel mike converts the sound produced by the musical movement into electrical impulses. These impulses are fed to the control grid of vacuum tube V1 (see Fig. 2). A dynamic microphone cannot be employed at this point, be-



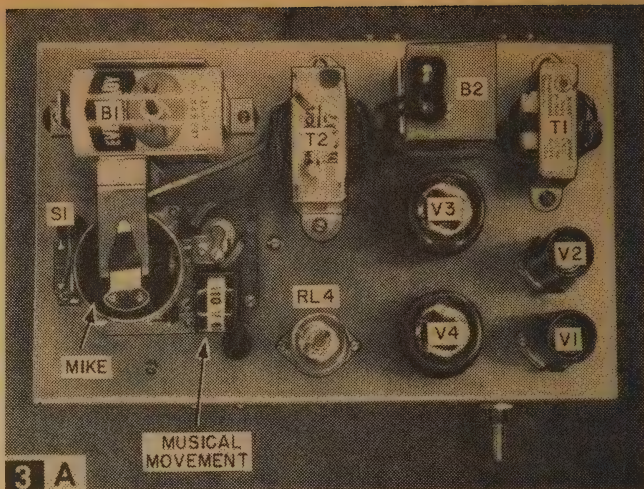
cause it would be sensitive to the hum resulting from the magnetic field that surrounds the motor. A vibration pickup mike, as used for electric guitars and similar musical instruments is also impractical, because of its sensitivity to the mechanical noises generated as the motor and its associated gearing operates.

Because of this mechanically generated noise, a relatively shockproof bracket (see Fig. 6) must be used to mount the mike. This bracket makes use of a small section of plastic sponge to deaden vibrations which would otherwise travel up the mount and excite the mike.

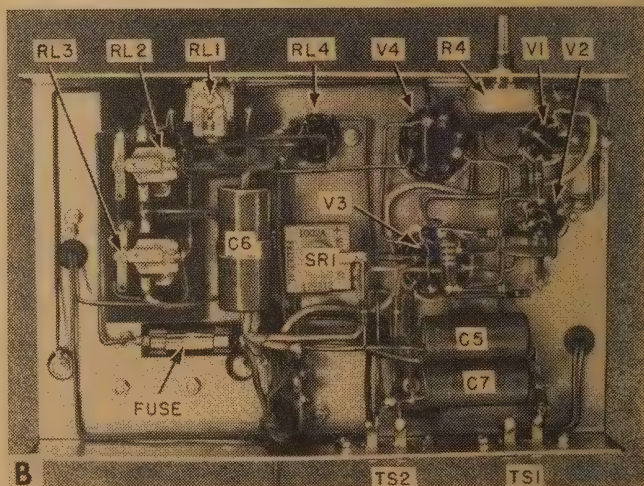
In most respects, the four-tube amplifier is of conventional design. Since the power capability of a single 3Q5GT is rather limited, two of these tubes are operated in parallel. The extra 3Q5GT provides a very useful increase in power output. Parallel, instead of push-pull operation was chosen because no phase inverter tube is needed and an inexpensive output transformer can be employed. Preliminary tests of the completed amplifier showed that its overall gain was so high that there was a tendency toward self-oscillation when the volume control was well advanced, but the addition of resistor R9 (see Fig. 2) provided sufficient inverse feedback to lower the gain and completely eliminate the oscillation problem. The use of inverse feedback also improved the frequency response and minimized distortion in the output stage.

When the annunciator is first plugged into the line, no power can be drawn because relay RL2 is open. However, as soon as the pushbutton is pressed current from the 9-v battery will flow through the coils of RL1, RL2, and RL3. Relay RL2 closes and applies 110 volts to the primary of T2, to the heater of delay relay (RL4), and to the motor of the musical movement. Relay RL1 closes and applies filament power to the tubes. The amplifier becomes operative at once and the tones of the musical movement are heard via loudspeakers placed in convenient spots throughout the home.

Relay RL3 also closes at the instant the button is pressed. The contacts of RL3—as long as RL4 or S1 remain closed—act as a short across the pushbutton. Thus, current continues to be supplied to the coils of RL1, RL2 and RL3 via the contacts of RL3, even



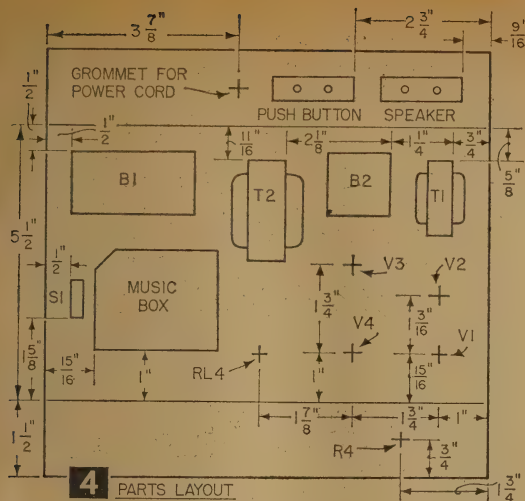
Top-chassis (above) and bottom-chassis (below) views of annunciator circuitry.



after the visitor stops pressing the button.

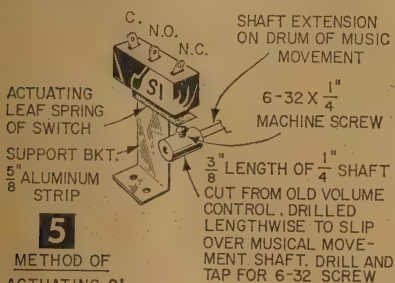
As the unit operates, the heater in RL4 warms up. After a period of approximately 10 seconds, it becomes so hot that the bi-metal arm in RL4 bends far enough to open the normally closed contacts of this relay. At the moment, this action has no effect on the operation of the musical movement or amplifier because the points of RL4 are paralleled by those of S1, the miniature snap action switch operated by the cam on the shaft of the musical movement. As soon as the 20-second tune has been completed, the cam opens S1, breaking the current path from the 9-v battery to the coils of RL1, RL2 and RL3. The relays open and the entire unit shuts down until such time as it is reactivated by the push-button.

The cam on the music box is constructed from a short length of volume control shaft and a 6-32 machine screw (see Fig. 5). This

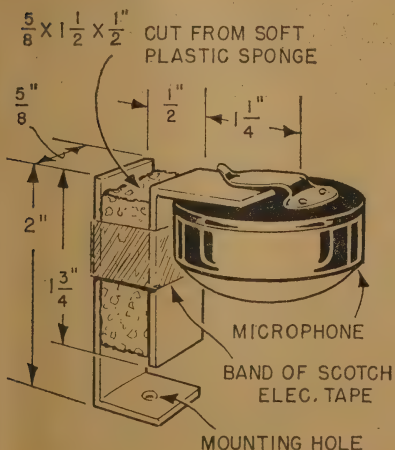


cam must be so positioned that it actuates the lever of S1 when the tune on the barrel has been completed.

The power transformer T2 in Fig. 3A happens to be a surplus unit designed to provide 125 v at 25 ma and 6.3 v at 1 amp. A suitable substitute would be a Knight 62G008 which furnishes 125 volts each side of center-tap,



5
METHOD OF
ACTUATING S1



6
SHOCK PROOF MOUNT
FOR MICROPHONE

plus 6.3 v. Only half of the high-voltage secondary on the 62G008 should be employed with the center-tap going to R12 and one end of the high-voltage winding going to R10. Since the other end of the secondary and the 6.3-v leads are not required, clip them short and insulate with electrical tape.

The two small batteries B1 and B2 are subjected to so little use in this particular device that they can be expected to have almost shelf life. Consequently, the battery cost per month will be insignificant.

Constructed on a 1 1/2 x 5 1/2 x 9-in. aluminum chassis, the amplifier is easy to wire since there is plenty of room between the components for the tip of a soldering iron. The armatures of the three small relays are directly connected to the frames. Therefore, RL2 and RL3 should be insulated from the chassis. Figure 3B shows how these relays are mounted on a thin sheet of Bakelite. Any easily worked plastic can be substituted for the Bakelite.

No knob is needed on the shaft of R4. Once the volume has been set to the desired level, no further adjustment is necessary. Battery B1 is kept in place with a home-made battery holder (or use a commercially built holder, such as a Keystone type 175). Two L-shaped brackets bent from small pieces of aluminum clamp battery B2 in position. Since the No. 5

MATERIALS LIST—MUSICAL ANNUNCIATOR

Desig.	Description
R1, R6, R8	2.2 megohm, 1/2 watt (Allied 1MM000)
R2	1 megohm, 1/2 watt (Allied 1MM000)
R3, R7	220,000 ohm, 1/2 watt (Allied 1MM000)
R9	330,000 ohm, 1/2 watt (Allied 1MM000)
R10	75 ohm, 1/2 watt (Allied 1MM000)
R11	560 ohm, 1/2 watt (Allied 1MM000)
R12	330 ohm, 1/2 watt (Allied 1MM000)
R4	500,000 ohm volume control (Allied 29M773)
R5	33,000 ohm, 1 watt (Allied 1MM020)
C1, C2, C3, C4	.01 mfd. disc ceramic capacitors (Allied 11L437)
C5	12 mf., 150-v electrolytic capacitor (Allied 15L194)
C6	20-20 mf., 150 v electrolytic capacitor (Allied 15L247)
C7	100 mf., 15 v. electrolytic capacitor (Allied 16L236)
RL1, RL2, RL3	Sigma 11F-1000G-SIL SPDT Relay (Allied 75P068)
RL4	Amperite 115C10T miniature delay relay (Allied 75PP296)
T1	Stancor A-3822 4 watt universal output transformer (Allied 64G005)
T2	Knight power transformer 125-0-125 v, 25 ma; 6.3 v, 1 amp (Allied 62G008)
B1	1 1/2 v size D A battery (Allied 80J903)
B2	9 v battery VS-305 (Allied 80J838)
SR1	Federal 1002A, 65 ma. rectifier (Allied 4A606)
S1	Unimax USML SPDT Subminiature leaf switch (Allied 34B848)
TS1, TS2	2 screw terminal strip (Allied 41H505)
Mic	Crystal lapel Mike (Lafayette PA-9)
Battery Holder	for 1 size D cell (Lafayette MS-175)
Fuse	3AG 1/2 amp (Allied 52B232)
V1, V2	1U5 tube
V3, V4	3Q5GT tube
Musical movement	Reuge ELR 1.18 110 v, 60 cps with extended shaft. From Novelties of Distinction, 131 West 42nd St., New York 36, N. Y., or direct from the manufacturer, Reuge S.A., 26, Rue des Rasses, Ste. Croix, Switzerland.
	two octal tube sockets (Allied 40H058)
	one 9-prong miniature socket for RL4 (Allied 41H534)
	two 7-prong tube sockets with shield (Allied 40H194)
	two 1 3/4" tube shields (Allied 40H198)
	open-end chassis 1 1/2 x 5 1/2 x 9" (Allied 80P440)
	fuse clip (Allied 52B292)
	three terminal tie-point strip (Allied 41H501)
	5" loudspeaker, 3.2-ohm voice coil (Allied 81D617)
	wall baffle for 5" speaker
	wire, power plug, assorted 4-36 and 6-32 screws and nuts

Components available from Allied Radio Corp., 100 N. Western Ave., Chicago 80, Illinois, and Lafayette Radio, 165-08 Liberty Avenue, Jamaica 33, New York.

pin on a 1U5 and the No. 1 and 6 pins of a 3Q5GT are not connected to elements within the tubes, those terminals on the sockets can be used as convenient tie points to support resistors and capacitors. Grid bias for the 3Q5GT's is obtained from the voltage drop across R12. Capacitor C7, the bias filter capacitor, must be wired with its positive terminal grounded.

Locate the amplifier where output from the speakers cannot get back into the microphone to produce acoustical feedback—put it in the basement or, if you have no basement, in a utility room. Wherever you put the amplifier, make certain that it is out of reach of your youngsters. With the exception of the terminals on the motor of the musical movement, which ought to be insulated with electrical tape, all high voltages appear only on the under side of the chassis. A fuse has been included as a protection against overheating which might result from a shorted component.

Once it has been permanently installed, plug the amplifier into the power line and run a pair of wires from TS2 to a pushbutton near the front door. Run a second pair of wires from TS1 to the main speaker which may be a 4-in. or 5-in. unit with an impedance of 3.2 ohms. Mounted in a wooden baffle, this speaker can be placed at a convenient point in the most lived-in section of your

home.

Overall volume in any one part of the house need not be high, since additional speakers can be placed in those areas where the sound of the main speaker does not penetrate adequately. These extra speakers can be wired in parallel with the main speaker as shown in Fig. 2. Since the desired volume level at remote locations will normally be less than that of the main speaker, intercom replacement units with 45-ohm voice coils will work effectively in these spots. Each intercom speaker will give adequate acoustical output to cover a room or two, but because of the relatively high impedances involved, even when several are connected in parallel, they will not seriously shunt the 3.2-ohm main speaker.

The electronically amplified music box, as a replacement for an ordinary door bell or chime has a number of important features, in addition to its basic one of providing pleasant music. Unlike the ordinary bell or solenoid-operated chime, it plays for a period of 20 seconds, whether or not the pushbutton is held down. The sound of a doorbell is usually of rather short duration and is often masked by noises around the house. On the other hand, the continued output from the music box tends to get through such distractions as children's voices, loud hi-fi's, clacking typewriters, pounding hammers, etc.



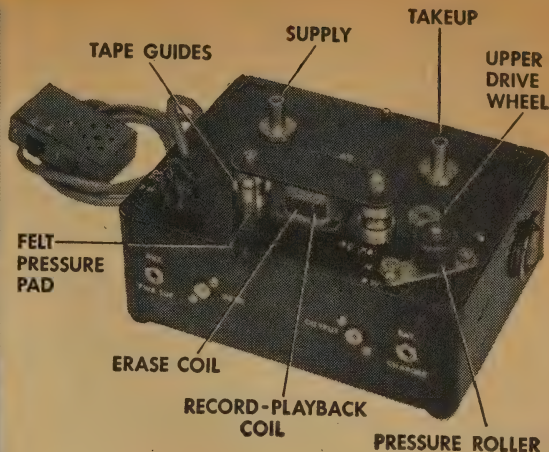


Standard flashlight batteries or the new, D-size, rechargeable storage batteries may be used in this instant-ready recorder. Its motor-driven fast rewind and erase features make it possible to use the same tape over and over. Depending on where you buy, and what you have on hand, drive parts should cost between \$40 and \$60. High precision is not required.

FLICK the mike switch and this battery-powered, 4-lb. midget starts recording immediately. There's no waiting for tube warm-up and no searching for an electrical outlet. And since playback speed is the standard $3\frac{3}{4}$ -ips used on home recorders, you can play your tapes with loudspeaker volume through a radio or hi-fi unit, instead of the combination mike-speaker; or—if more volume is required on playback—you can play them on any standard home-type recorder that has $3\frac{3}{4}$ ips speed. A built-in jack plug input also permits you to record voice or music directly from your radio or TV.

The switch on the mike case starts and stops the record motor. For dictation, you can wire in a 4-prong plug and foot switch for the convenience of a typist. If you need loud-speaker volume, feed the output into an amplifier, or use the input jacks on suitable radios, or the amplifier section of tape recorders.

Construction starts with the metal parts detailed in Fig. 6. First scribe lines at the desired points for cuts and saw and then clamp in a vise along the line, using a square to make sure that the metal is vertical to the vise jaws. Next, lay out the hole locations with scribe and center punch and, with the part held firmly in a drill press vise, start the holes with a $\frac{1}{16}$ -in center drill chucked in a drill press. Use oil and finish the holes to size with sharp drills. File the three notches in the forward-reverse idler lever, but leave the



Miniature Tape Recorder

By JAMES E. PUGH

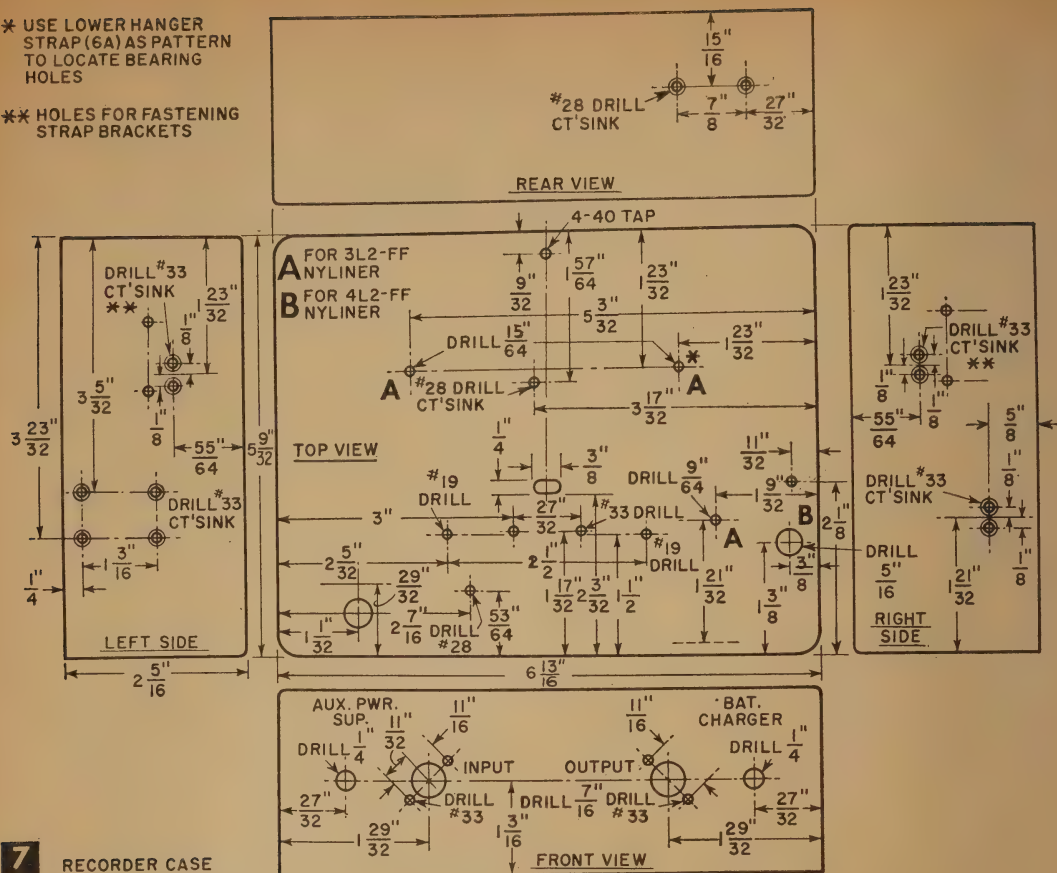
center notch slightly shallow, since it must be deepened later.

Locate the holes in the plastic case with a machinist square and scribe as in Fig. 7, and back up the plastic with a wooden block to prevent chipping when drilling. For the holes for the two tape spindles, use the metal bracket that goes inside the case as a template to assure matching center-to-center spacing. Countersink each hole requiring a Nyliner bushing inside the case and enlarge them with a tapered hand reamer just enough to obtain a free-turning fit with the shaft when bushing is installed. Each shaft must spin freely in its bushing for smooth tape motion, but it cannot be so loose that it wobbles. Nyliner bushings are split at one side to facilitate this kind of adjustment. Insert them by pressing the lower pointed end, of the bushing inward and spiraling clockwise into the hole with your fingers, working from the outside of the case, so the broad flange will be on top.

Next, make up the tape drive parts shown in Fig. 8. The three idler wheels must turn freely on their shafts. Mount the forward and rewind idler lever as in Fig. 9. Tighten the screw on the threaded shaft until the compression washer holds the shaft firmly, but not locked in place. Then, holding the first lock nut with a thin wrench to keep the shaft from turning, tighten the second lock nut. It should now be possible to slide the idler along the length of its slot without rocking.

* USE LOWER HANGER STRAP (6A) AS PATTERN TO LOCATE BEARING HOLES

**** HOLES FOR FASTENING
STRAP BRACKETS**



7 RECORDER CASE

from the other wheels and both takeup and rewind shafts turn freely. Cover the idler wheels and clean this part carefully each time it is filed to prevent filings from getting on the wheels and inside the case.

To set the record motor tension, fasten the lower drive wheel surface about $\frac{3}{8}$ -in. above the lower bearing hanger. Adjust the motor spring tension lever until the drive wheel can be rotated but a noticeable drag from the motor is felt. Too light a tension will allow slippage between motor and tape drive shafts, and too heavy a tension will cause pressure marks in the rubber rim of the drive wheel. The record motor speed is adjusted with a small screw through a hole in the motor case, turning clockwise for more speed. When the upper drive wheel rotates at 120 RPM, the tape will move at $3\frac{3}{4}$ *ips*.

After these adjustments have been made, run the mechanism both forward and in reverse for several minutes. Then put the tape reels on and check to see that the tape feeds through the drive smoothly and is not pulled too tightly by the takeup. If a slight loop is left in the portion of tape between takeup reel and drive wheel it should hold the loop smoothly, gradually becoming smaller as

more tape is wound on the takeup reel.

Wiring. The amplifier is wired as in Figs. 10 and 11. It is best to solder in resistors first, capacitors next, then diodes and transistors. Some of the wire in the four-conductor microphone cable is excellent for wiring as it is small and color coded. Also, short sections of the insulation can be removed from this wire for making color-coded spaghetti.

After the amplifier is completed, wire the upper section of switch S2 (Fig. 11). Mount it in the case and wire in the tape head, motors, and jacks cutting all wires that connect to the amplifier to the approximate length needed. Mount the amplifier in place and finish the wiring. The microphone-speaker is housed in a small plastic box (Fig. 12).

Throw the function switch (S2) to *Playback* (PB) and listen for a weak motor noise in the earphone. Also check to see that both motors rotate in the correct direction. (If not, reverse the motor leads.) Then adjust the tape pressure pad to hold tape lightly against the tape head. Now you can make a recording. Set the potentiometer R7 about two turns above the full counterclockwise (minimum) position, and the function switch, function lever, and microphone switch to *Record*.

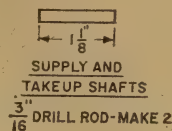
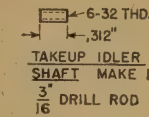
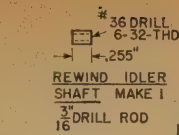
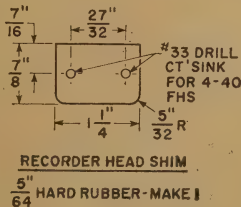
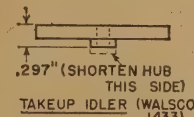
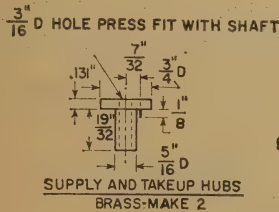
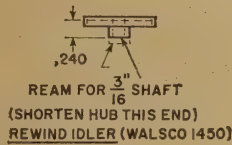
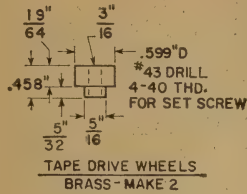
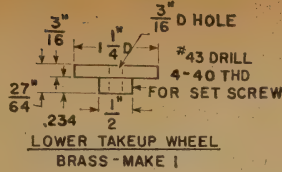
Hold the microphone about 8 in. from your mouth and speak in a normal voice. Play the recording back and adjust the tape pressure pad for maximum volume but be sure that it is not tight enough to drag on the tape. Now make another recording and, if it's weak, turn the volume control up $\frac{1}{2}$ turn (clockwise) and try again. Repeat until the recording is of a suitable volume but not distorted from over-driving. Minor adjustments can now be made in the tape transport mechanism for smoothest recordings, and the recorder is ready to use.

How it Works. The tape feeds from the supply (left) reel across the first tape guide. From here it passes across the erase coil (on the right side of the head). The erase coil thus wipes off any previous recording before it reaches the record coil. The pressure pad holds the tape in contact with the head.

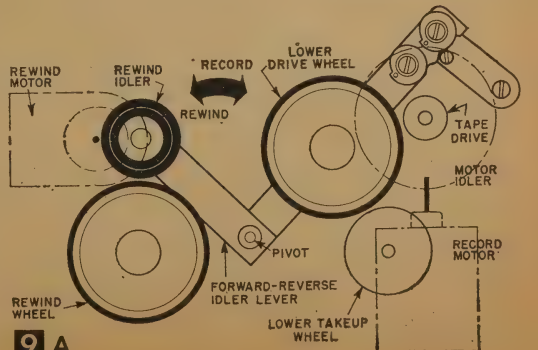
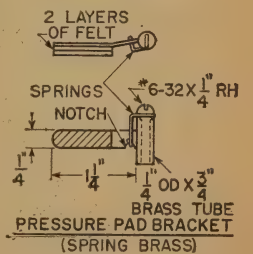
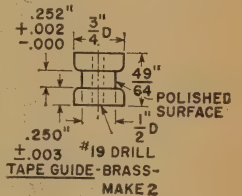
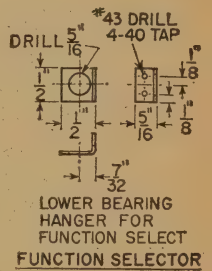
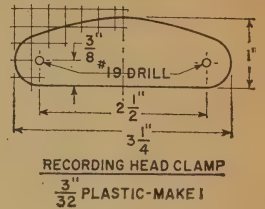
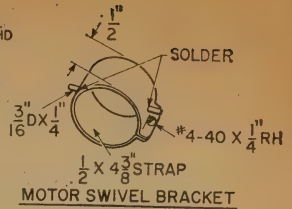
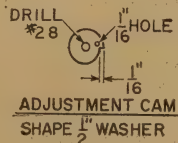
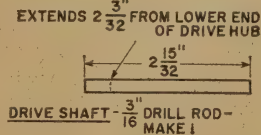
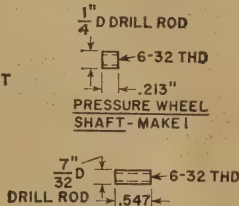
After the tape leaves the recording head it passes between the upper drive wheel and pressure roller and from here to the takeup reel. On playback the erase coil is disconnected by switch (S2) and the recorded signal on the tape energizes the record-playback coil which is now connected to the amplifier input. The amplified signal is fed to the magnetic microphone—now used as an earphone.

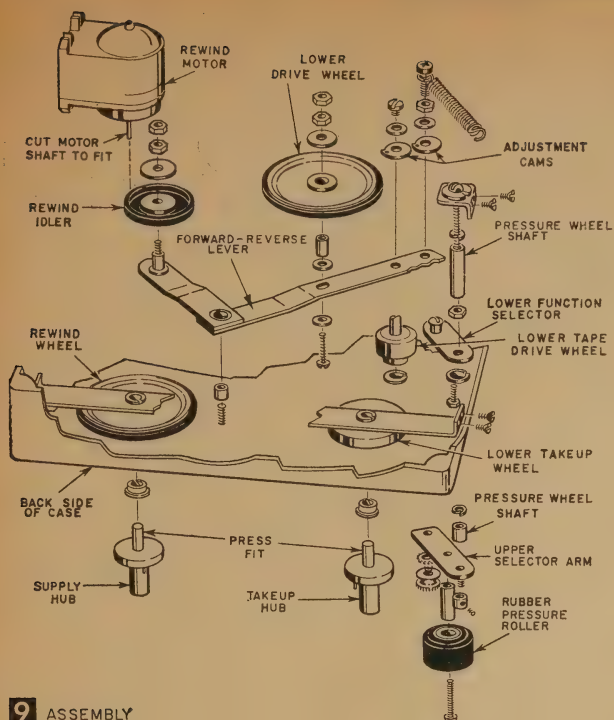
A simple three-stage common-emitter amplifier is used. The first two transistors are the PNP and the last the NPN type to allow the mike and record coil return leads to connect directly to common, on both record and playback, without using decoupling filters. High-frequency pre-emphasis is used on *Record* with flat response being used on *Playback* providing better quality with minimum distortion.

Motor noise is removed from the amplifier dc power source with V4, which acts as stable



8 TAPE DRIVE PARTS





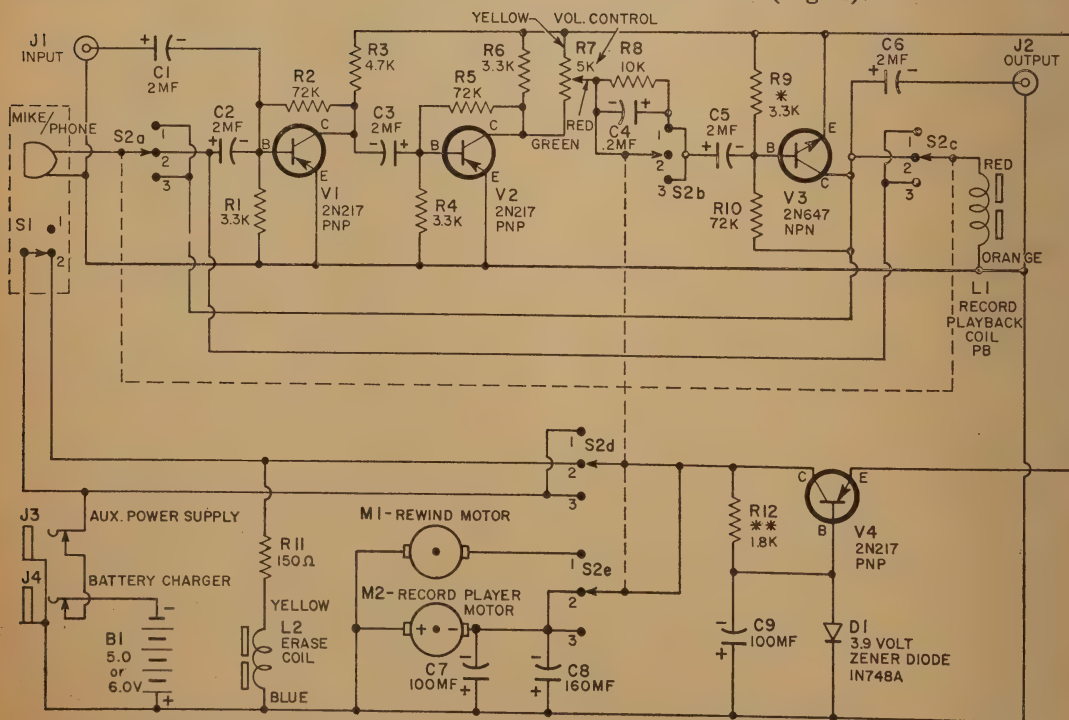
9 ASSEMBLY

voltage regulator. The voltage across the zener diode (D1) is constant at 3.9 as long as the input voltage does not fall below this value. Because this diode is in the base circuit, it determines the voltage output level at the emitter of V4. Since the base voltage is constant, the output voltage will thus be constant regardless of variations at the input (at V4 collector); therefore, variations due to motor noise will be filtered out.

Battery Notes. You can use either rechargeable Sonotone nickel-cadmium, or flashlight cells.

The nickel-cadmium cells provide nearly constant output voltage throughout their charge, whereas the flashlight cells drop off as they are used. Constant voltage is an advantage in maintaining motor speed; however, the 5-volt level approaches the lower limit for best governor operation.

The nickel-cadmium cells are slightly shorter than flashlight cells and a short 4-40 *rh* screw is threaded into the positive terminal of each battery clip to compensate for the difference (Fig. 4).



* ABOUT 3.3K. ADJUST FOR APPROX. .5 MA. L1 CURRENT

** ABOUT 1.8K. ADJUST FOR APPROX. 1 MA. DIODE CURRENT
OUTPUT FROM V4 EMITTER SHOULD BE ABOUT 3.9 VOLTS

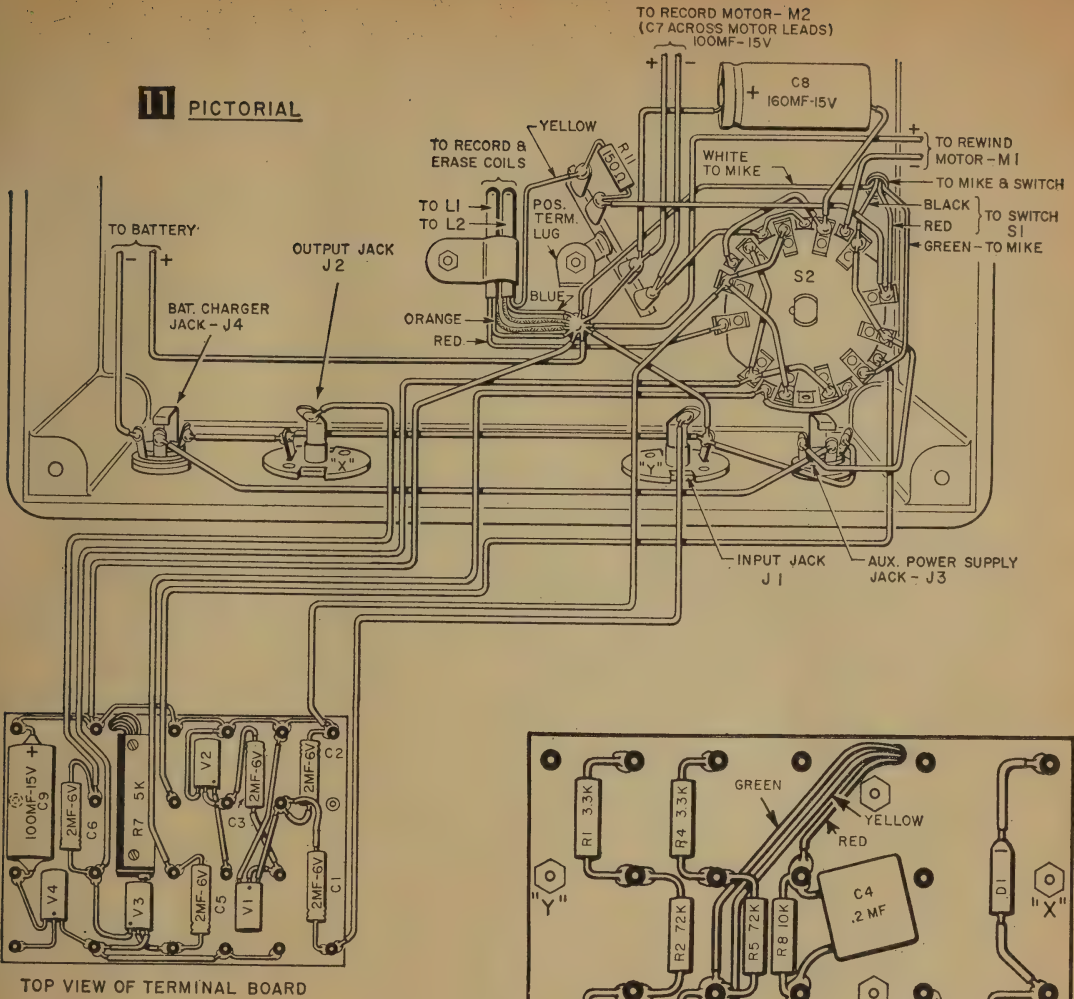
SWITCH POSITIONS

S1 1 = OFF
2 = RECORD

S2 1 = REWIND
2 = RECORD / OFF
3 = PLAYBACK

10 SCHEMATIC DIAGRAM

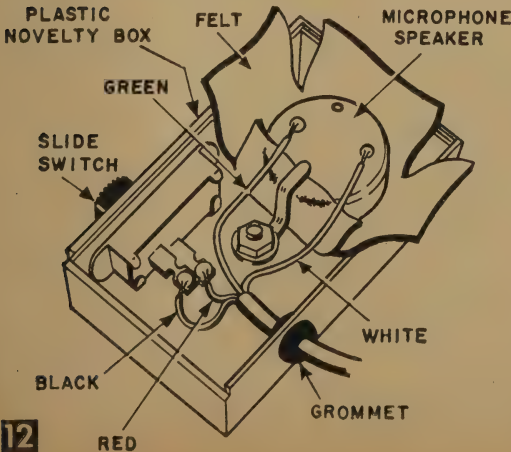
11 PICTORIAL



TOP VIEW OF TERMINAL BOARD

BOTTOM VIEW OF TERMINAL BOARD

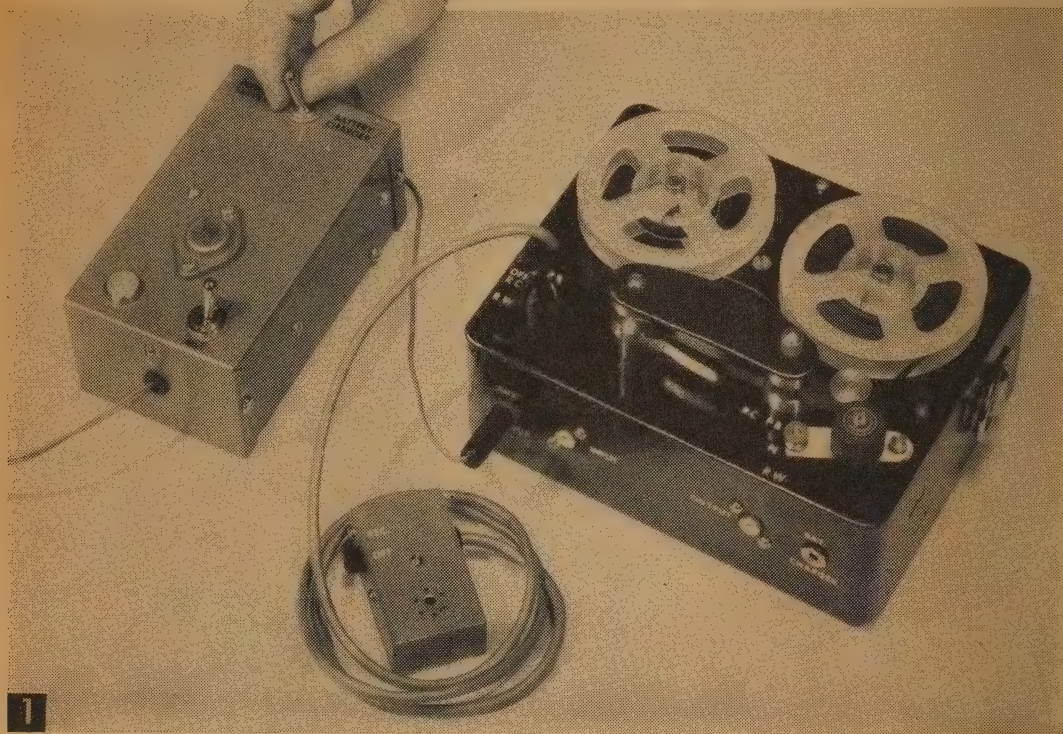
USE ACTUAL SIZE DRAWING
AS DRILLING TEMPLATE.



If you use flashlight cells, select Eveready Type D99, a leakproof type, to avoid damage to the recorder. Jacks are provided to allow recording an external signal; to feed the amplifier output to an external power amplifier; to connect an external power source such as a 6-volt automobile battery or an auxiliary ac power supply; and to connect the charger to the batteries. When the external power supply is connected, internal batteries are disconnected; when the charger is connected, amplifier and motors are disconnected.

Accessories. The tape cartridge (Fig. 5), allows the recorder to be carried as a portable unit in any position. Plans for a separate power supply appear overleaf this handbook.

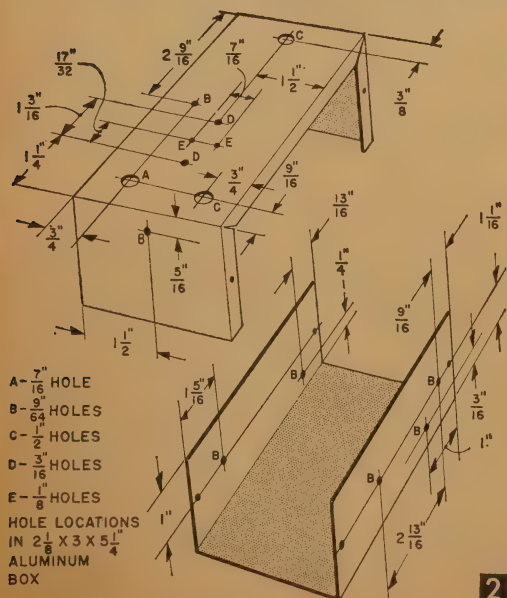
Flip the toggle switch, change the plug, and the power supply becomes a battery charger. It will restore the storage battery pack in the recorder case to full strength overnight.



**Dual
Purpose**

Tape Recorder Power Supply

By JAMES E. PUGH



DESIGNED as an accessory for the portable tape recorder, this combination power supply will either recharge the recorder storage batteries, or permit you to operate the recorder without batteries on house current.

The unit can double as an experimenter's power supply, and to charge miniature storage batteries used in other types of equipment, provided that the charging current (225 ma.) and the charging voltage (5.1, or 6.2-volt) are the same.

While the four *Sonotone* rechargeable batteries used in the portable tape recorder 5-volt power pack will operate continuously for many hours, they must be eventually recharged. This a-c power supply unit guarantees that you'll be able to use the tape recorder for continuous dictation or desk use, even though the batteries may be exhausted.

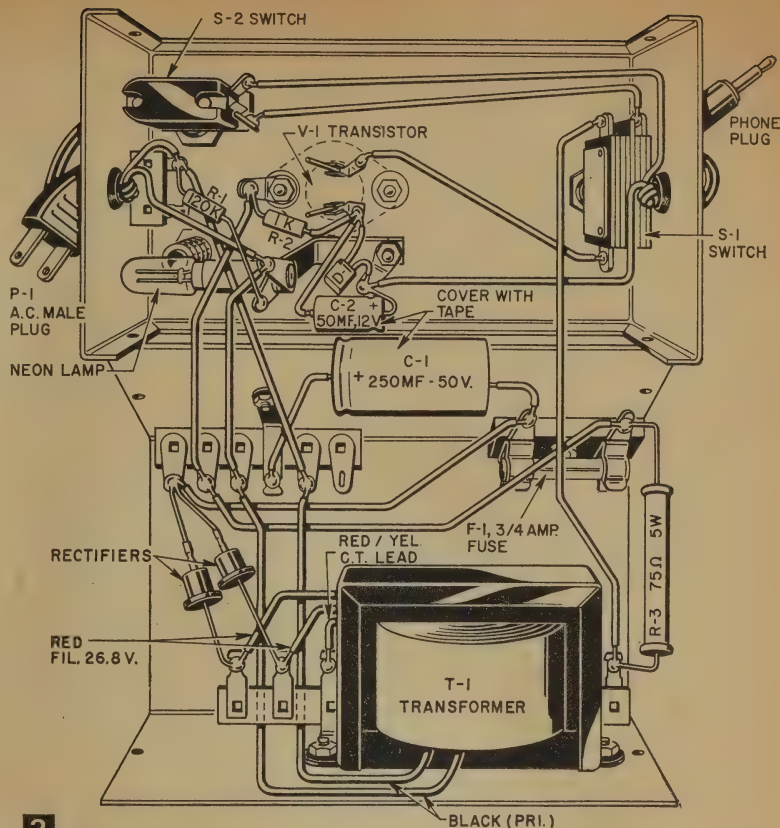
Begin construction by drilling all of the holes (Fig. 2) in the aluminum box. Wire the switches and other parts according to Figs. 3 and 4. Flexible #24 speaker cable is suitable for the a-c power cord and the connecting cord since the wattage of this unit is very low.

The power supply regulator, transistor VI, is mounted on top of the aluminum box to provide suitable heat dissipation. Drill the mounting holes in the box first, and then scribe the outline of the transistor case. Scrape away all paint within this outline to allow better thermal contact with the box, sand the surface smooth, and remove all burrs from the insulator holes to prevent puncturing the mounting insulator.

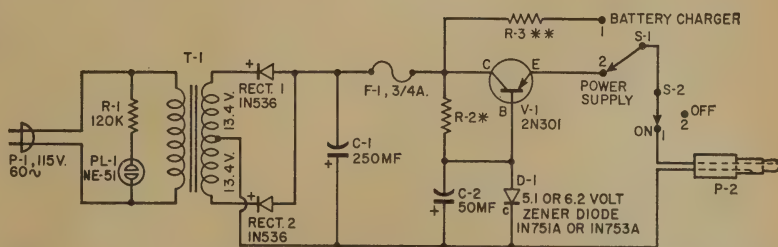
Make a thin mica mounting washer by scribing the transistor case outline on a piece of thin mica. Drill the two mounting holes, cut along the outline with sharp scissors, and then split the mica into thin layers about .002, or .003-in. thick. Coat both sides of the washer with light oil, and mount the transistor with 6-32 machine screws, washers, and nuts. Use an ohmmeter to make sure that the aluminum box, and good.

Clip off the ends of one of the unused mica mounting washers, and use it as an insulator on the underside of the box. Make the emitter and base contactors from the contacts of a miniature 7 pin wafer tube socket. When soldering to the transistor contacts, remove the transistor to avoid heat damage. Mark the letters B and E near the base and emitter pins to identify them.

Transformer T1 steps the line voltage down to 13.4 volts *a-c* after which it is changed to *d-c* by the full wave rectifier consisting of



3 PICTORIAL



4 SCHEMATIC

*ABOUT 1000 Ω . FOR DIODE CURRENT OF 8 TO 10 MA. OUTPUT FROM V-1 ÉMITTER SHOULD BE APPROXIMATELY 5.1 OR 6.2 VOLTS (SEE TEXT)
**ABOUT 75 Ω FOR CHARGING CURRENT OF 200 TO 225 MA.

***ABOUT 75 Ω FOR CHARGING CURRENT OF 200 TO 225 MA

Rect. 1, and Rect. 2. Transistor V1 and Zener diode D1 form a voltage regulator that filters and maintains the output voltage at the desired level. The same kind of circuit was used in the motor noise filter of the recorder amplifier circuit.

The power supply output voltage should correspond closely to that of the batteries used so as to maintain more consistent motor speed. For example, with four 1.25-volt nickel cadmium cells, use a 5.1-volt Zener diode (IN751A). On the other hand, if you use four flashlight dry cells, 6 volts will result; therefore use a 6.2-volt zener diode (IN753A) for D1.

MATERIALS LIST TAPE RECORDER POWER SUPPLY

No. Req'd	Size and Description
1	D1—5.1 or 6.2-volt voltage regulator Zener Diode (Texas Instrument IN751A or IN753A, see text)
1	F1— $\frac{3}{4}$ ampere fuse, type 3AG; fuse holder (Littelfuse 3510011)
1	P1—a-c power plug
1	P2—sub-min phone plug (Switchcraft 750)
2	Rect. 1, Rect. 2—1N536 silicon rectifiers (RCA)
1	S1—SPDT toggle switch
1	S2—SPST toggle switch
1	T1—26.8 v., 1A. filament transformer (Triad F-40X)
1	V1—2N301 transistor (RCA)
1	PL1—NE-51 neon lamp
Capacitors	
1	C1—250uf, 50-v. electrolytic capacitor (Mallory TC-50025)
1	C2—50uf, 12-v. ultra-miniature electrolytic capacitor (Barco P12-50)
Resistors	
1	R1—120 K, $\frac{1}{2}$ w., 10% carbon resistor
1	R2—about 1K, $\frac{1}{2}$ watt, 10% carbon resistor (see Fig. 4)
1	R3—about 75 ohm, 5 w., resistor (Sprague 27E)
Hardware	
1	2 $\frac{1}{8}$ x 3 x 5 $\frac{1}{4}$ " grey hammertone aluminum box (Bud CU-2106A)
1	On-off toggle switch plate
7 ft.	length 2-conductor chrome vinyl speaker cable (Belden 8782)
1	insulated tie point
1	miniature 7-pin wafer tube socket
1	pilot light socket, miniature bayonet (Dialco 720)
1	$\frac{1}{2}$ " pilot light jewel, white (Dialco 10006-435)
misc	rubber grommets, screws, nuts, solder lugs, mica, insulated, extruded washers, decals, plastic spray or lacquer, wire resin core solder
	Parts available from Allied Radio, 100 N. Western Ave., Chicago 80, Illinois

When charging the Sonotone batteries, resistor R3 bypasses the regulator circuit to provide a constant current. Between 200 and

225 ma. is required for proper charging. About 16 hours are required for a full charge at this rate, though the batteries may be left connected on charge for much longer time without harm.

The pilot light, indicating that the power supply or charger is ready for use, is lit whenever plug P1 is in the 115-volt socket, since the on-off switch does not control this part of the circuit.

When you connect the accessory unit (Fig. 1) to the recorder, always be sure that toggle switch S1 in Fig. 3 is thrown to the position corresponding to the jack to which the plug P2 is connected. When plug P2 is connected to the auxiliary power supply jack on the recorder, the internal battery pack is automatically disconnected. Be sure that S2 is at Off when connecting and removing plug P2. Also remove the plug from the charger jack when not charging to prevent the batteries from draining back into the charger circuit.

Polish "Locks" TV Adjustment

• When you've just finished making a critical adjustment on the service control of a TV set, "lock" the screw firmly against mechanical shocks by coating its threads with fingernail polish. If the control ever needs readjustment, a drop or two of fingernail polish remover will unlock it in a matter of seconds.—JOHN A. COMSTOCK.



"Lady wanted to know could we do anything with this. Hasn't made a move for two weeks."

The Typacode

By BERNARD DICKMAN

With the Typacode you can send Morse code as fast as you can type—whether you know the code or not. Thus, even a person who does not know Morse code can test you on your knowledge of it

WITH the Typacode, you press a button indicating the letter of your choice and this letter is automatically translated into the correct Morse code pulses. The number of words per minute you can send out with Typacode depends upon the speed of the motor you use to turn the shorting rotary switch, the "brain" of the device. Assuming five letters to the average word, a 100-rpm motor will permit you to send 20 words per minute; a 60-rpm motor, 12 words per minute, and so on.

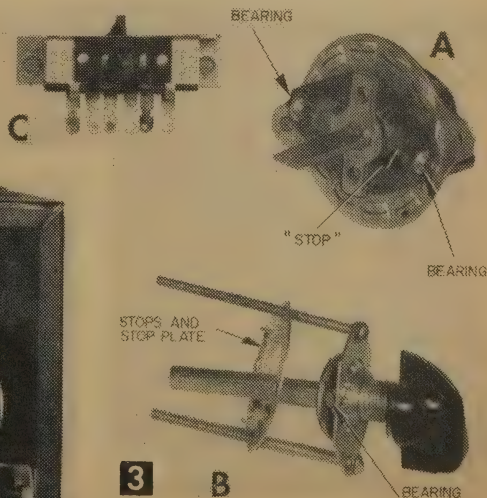
But motors aren't usually built to run that slowly, and a gear train is needed to reduce their speed (and increase their torque). I used a worm gear with an 80-tooth gear to get an 80:1 gear ratio and reduce the 6,000 rpm's of the motor I used to 75 rpm. With my Typacode I can send about 15 words per minute. With speed reduced 80 times, torque is increased 80-fold, from 1.5 oz.-in. to 120 oz.-in. The motor I used consumes seven watts. The motor you use should have these approximate specifications in order to be able to turn the rotary switch. Most sewing machine or small fan motors are adequate, or try such a motor as the Hurst 60 rpm (RSM-60), Allied Radio catalog No. 76P862.



1

The number of words the device is capable of sending per minute may also be varied by the introduction of a variable voltage transformer to control the speed of the motor. This will help in adjusting word out-

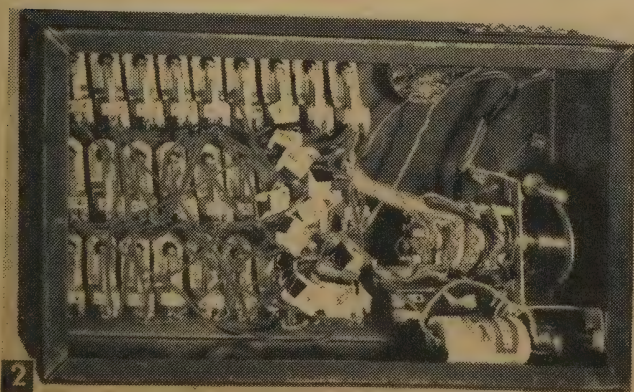
Standard rotary switch is shown in A; stop to be twisted off or bent down, bearings to be removed. In B is shown a miniature rotary switch. Its stop must be twisted off or bent down, or plate taken off; bearing to be removed. In C is shown an altered (as described in text) slide switch for slide-switch version of Typacode.



3

B

BEARING



2

Bottom view of Typacode, showing tagged wiring.

put to the sender's typing ability and the auditor's understanding.

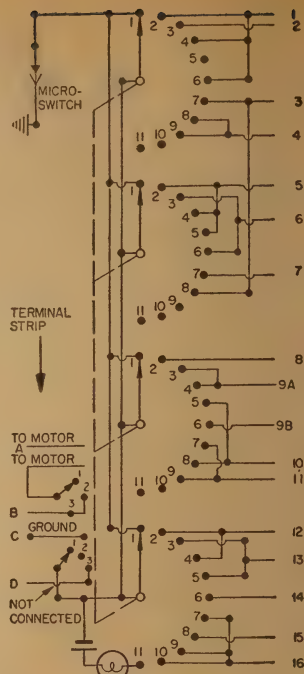
Construction. First remove the bearings which cause the rotary switch to click when turned (see Fig. 3). Pry them out with a screwdriver. Also, remove all of the "stops" which prevent the switch from turning continuously in one direction.

There are two basic versions of the device. One uses push-button, and the other uses spring-return slide switches. The spring-return slide switch version is somewhat cheaper, but a bit more difficult to operate. Choose the version you want to build (Figs. 1 and 2 show the push-button version), buy materials, and in either case, wire the shorting gang switch first (Fig. 5 for push-button unit, Fig. 6 for slide-switch unit).

If the gang switch is to be turned clockwise by the motor, Fig. 5 (and Fig. 6) is shown as one looks at the front of the switch. If, on the other hand, the switch shaft is to be turned counterclockwise, reverse the connections. That is, assume that the diagram shows the gang switch as you would look at it from the rear, and wire accordingly. (Remember that gears sometimes

ONE MAKE POS. EACH ON SW.	IS TO BE CONNECTED TO WIRE(S)	WITH MORSE CODE EQUIVALENT
A-----9A (SEE FIG. 8)	---	---
B-----1,15	----	----
C-----1,11	----	----
D-----1	----	----
E-----	---	---
F-----6,10	----	----
G-----5,7	----	----
H-----13,7	----	----
I-----2	---	---
J-----9,16	----	----
K-----1,7	----	----
L-----9,15	----	----
M-----5	----	----
N-----12	---	---
O-----5,3	----	----
P-----9,11	----	----
Q-----5,16	----	----
R-----9	----	----
S-----13	----	----
T-----8	---	---
U-----6,13	----	----
V-----3,13	----	----
W-----7,9	----	----
X-----1,4	----	----
Y-----1,16	----	----
Z-----5,11	----	----
PERIOD-----9A (HOLD FOR THREE FLASHES OF INDICATING LIGHT SEE FIG. 6)	----	----

4 CHART FOR WIRING PUSH BUTTON VERSION



5 WIRING OF PUSH-BUTTON VERSION
(SEE FIG. 4)

change the direction of rotation of the switch shaft.) For convenience, label the wires with tabs numbered as shown in the diagram. Allow approximately 5 in. of wire for connecting the rotary switch to the push-button or slide switches.

Now drill the holes in the chassis. Arrangement of the keyboard is left to the builder, but it will be found convenient to imitate that of the standard typewriter as closely as possible. Centers of holes for the Allied push-button switches are $\frac{3}{4}$ -in. apart in rows; the rows are spaced 2 in.

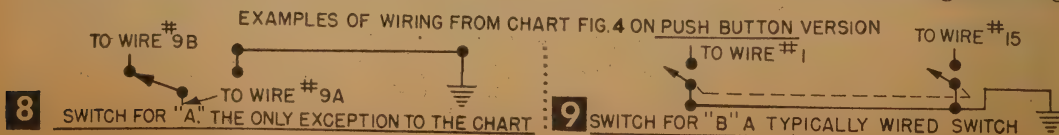
If you are using spring-return slide switches, adjust the sliding mechanism as shown in Fig. 3.

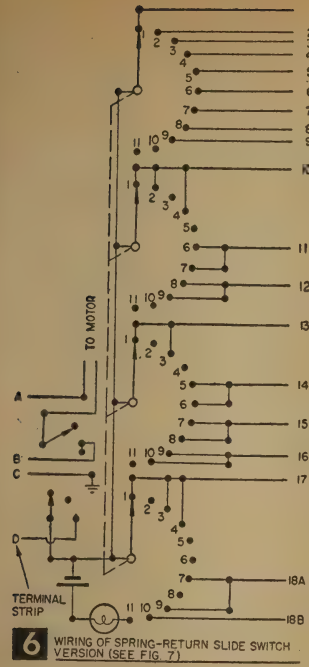
Next, install the switches. There is a ground lug

MATERIALS LIST—TYPACODE

Push-Button Version

- | No. | Req'd | Description |
|-----|---|-------------|
| 18 | DPST normally open push button switches for letters B, C, F, G, H, J, K, L, O, P, Q, U, V, W, X, Y, Z and period (Allied 34 B 997) | |
| 7 | SPST normally open push button switches for letters D, I, M, N, R, S, T (Allied 34 B 994) | |
| 1 | SPDT push-button switch for letter A (Allied 34 B 996) | |
| 1 | four pole, 12 positions per pole, shorting rotary switch (Only ten positions are needed for wiring; two extra needed for spacing between letters (Allied 34 B 906)) | |
| 1 | 3 x 7 x 12" chassis (Allied 80 PX 464). Only 7 x 8" is needed for push button keyboard, but since size of the motor will vary, the rest of the space needed is estimated with ample allowance for variations. | |
| 1 | motor of the type specified in article and gear assembly * | |
| 1 | 1½ v. flashlight battery | |
| 1 | indicator light assembly (Allied 52 E 475) | |
| 1 | miniature bulb (Allied 52 E 330) | |
| 1 | two-pole, 3 positions per pole, shorting rotary switch (Allied 34 B 303) | |
| 1 | SPST normally open micro switch (Allied 35 B 028) | |
- * Gears for either push-button or slide switch version are available from the Boston Gear Works with its main office at 14 Hayward St., Quincy 71, Mass. and offices throughout the country. Gear combinations are as follows:
 For a 100:1 gear ratio, a 100-tooth worm gear (Boston Gear G1023; hole dia $\frac{1}{4}$ ") and a worm (Boston Gear H15H; hole dia. $\frac{3}{16}$ ") are needed.
 For an 80:1 gear ratio, an 80-tooth worm gear (Boston Gear G1022; hole dia $\frac{1}{4}$ ") and a worm (Boston Gear H15H; hole dia. $\frac{3}{16}$ ") are needed.
 For a 60:1 gear ratio, a 60-tooth worm gear (Boston Gear G1024; hole dia. $\frac{1}{4}$ ") and a worm (Boston Gear H15H; hole dia. $\frac{3}{16}$ ") are needed.
 1 coupling between motor and switch or gear assembly





on the Allied push-button switches. Solder two different poles of each two-pole switch, and one pole of each one-pole switch to these lugs. This saves on wiring since now the poles on each switch are interconnected through the metal chassis. Otherwise (on slide switches) interconnect the different poles on each switch. The interconnected poles are referred to as "ground" and are connected to "C" on the terminal strip. Now install the motor, rotary switches, micro switch (this, only in push-button unit), bulb, and bulb socket, and letter the switches. For the push-button switches the letters were typed on a sheet of paper, punched out with a paper punch,

ONE MAKE POS. EACH ON SW....	IS TO BE CONNECTED TO WIRE (S)
A	4, 13
B	6, 8, 10
C	9, 10, 11
D	6, 10
E	1
F	8, 13, 14
G	5, 7, 10
H	5, 7, 13
I	1, 3
J	11, 16, 17
K	10, 11
L	6, 8, 17
M	5, 10
N	10
O	5, 10, 15
P	9, 11, 17
Q	5, 10, 18
R	6, 17
S	5, 13
T	1, 2
U	13, 14
V	5, 13, 15
W	11, 17
X	6, 10, 12
Y	10, 11, 16
Z	5, 10, 18A

(SEE FIG. 10)
PERIOD-----13, 4
HOLD FOR THREE FLASHES OF INDICATING LIGHT)

7 CHART FOR WIRING SPRING-RETURN SLIDE SWITCH VERSION

then glued to the surface of the button. Complete the wiring, using the chart Fig. 4 for push-button switches or chart Fig. 7 for slide switches. The first column in the charts refers to the switch, the second to the labeled wire or wires which illustrate connections to switches.

Use. The micro switch is thrown when you want to indicate the end of a word; otherwise the letter "e", a short pulse, is automatically sent. This "e" is a simplifying factor in wiring, since all letters start with a pulse. This pulse is elongated for a beginning dash. The automatic "e" and micro-switch are eliminated on the spring return slide switch unit, the micro switch being comparable to a spacing bar.

On the terminal strip, terminals A and B connect to the power source for the motor (ideally a variable voltage transformer). Terminals C and D connect to the wires otherwise connected to the sending key of the buzzer, code practice oscillator, etc.

Turn the two-pole, three-position switch to the second position. The motor is on, but the unit is not capable of sending code. Next turn the switch to the third position. Each time the motor makes a revolution the bulb will light, and shortly after a short pulse will be sent (only on the push-button unit). Depress the micro "spacing" switch (on the push-button unit only); the bulb will still light, but no pulse will be sent.

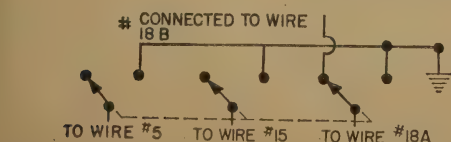
Directly after the bulb lights press the letter "a". A distinct "didah" will be heard. Release "a" and press "b" when the bulb lights again. Continue throughout the alphabet, checking against a standard table showing code equivalents for letters.

MATERIALS LIST—TYPACODE
Spring-Return Slide Switch Version

- | No. | Req'd | Description |
|-----|--|-------------|
| 2 | SPST normally open spring return slide switch for letters E, N * | |
| 11 | DPST normally open spring return slide switches for letters A, D, I, K, M, R, S, T, U, W and period* | |
| 13 | three-pole, single throw, normally open spring return slide switches for letters B, C, F, G, H, J, L, O, P, Q, V, X, Y* | |
| 1 | three-pole, double throw, spring return slide switch for letter Z * | |
| 1 | two-pole, three positions per pole, shorting rotary switch (Allied 34 B 303) | |
| 1 | 1 1/2 v. flashlight battery | |
| 1 | motor of the type specified in article, and gear assembly | |
| 1 | 7 x 12 x 3" chassis (Allied 80 PX 464). Only 7 x 9 in. is needed for slide switch keyboard, but since size of the motor will vary, the rest of the space needed is estimated with ample allowance for the variations | |
| 1 | four-pole, 12 positions per pole, shorting rotary switch (Only ten positions are needed for wiring; two extra needed for spacing between letters (Allied 34 B 906) | |
| 1 | miniature bulb (Allied 52 E 330) | |
| 1 | indicator light assembly (Allied 52 E 475) | |

* The only spring return slide switch available was a 3-pole, double throw switch. (Allied 34 B 496). If a 3-pole push button switch is available, this device may be built using it.

EXAMPLES OF WIRING FROM CHART FIG. 7 ON SLIDE SWITCH VERSION



10 SWITCH FOR "Z," THE ONLY EXCEPTION TO THE CHART

11 SWITCH FOR "B," A TYPICALLY WIRED SWITCH

An Electronic Antenna Relay

For the amateur who still throws an antenna switch, this inexpensive electronic relay will do the job automatically on any band up to two meters, and it will increase the sensitivity of most receivers

By JOE A. ROLF,
K5JOK

THE one-tube relay shown in Fig. 1 will handle up to 100 watts CW, or 85 watts phone. It is designed for use with any amateur antenna having an impedance of 25 to 300 ohms, and it permits instant CW break-in and greatly simplifies AM transmitter control. It also acts as a low-gain RF amplifier to improve receiver performance.

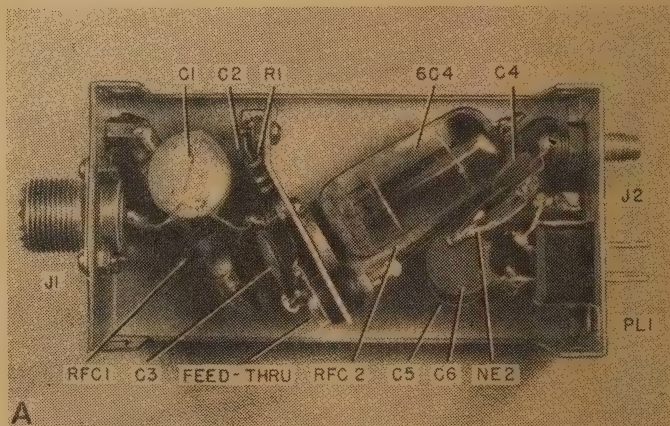
Figure 2 shows the circuit, Fig. 3 the connections to transmitter, receiver, and antenna. The T-R switch is inserted across the antenna feedline, in parallel with the transmitter. With the transmitter inoperative, the relay acts as a grounded-grid amplifier, allowing signals from the antenna to pass through to the receiver. When the transmitter is keyed, however, the relay's 6C4 is blocked and effectively isolates the receiver from the antenna.

The large biasing resistor R1 permits the 6C4 to conduct very weak RF signals to the receiver, while the strong signal from the transmitter creates a cut-off bias on the tube that prevents conduction to the receiver. Very little power is taken from the antenna since only a small amount of RF is required to block the 6C4.

The entire relay is built inside a $1\frac{1}{2} \times 2\frac{1}{2} \times 4$ -in. Minibox. For compactness and simplicity, the unit is powered by the station receiver or transmitter. A Cinch-Jones chassis plug receives the power cable; a miniature



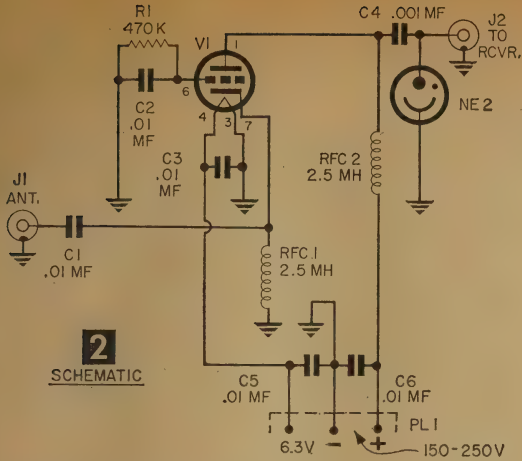
The completed electronic antenna relay, or T-R Switch, with the cabinet lid in place (above). This unit will permit instant break-in operation with CW transmitters of up to 100 watts input. It can also be used with phone transmitters running up to 85 watts. Interior of the relay cabinet showing construction and layout (below). The 6C4 is mounted on a small aluminum bracket (see Fig. 4) that also serves as a shield between the input and output components. The plate lead on the tube socket is brought through the bracket with a feed-through insulator.



coax antenna jack mounted beside it connects the unit to the antenna terminals of the receiver. A standard coax jack at the other end of the Minibox connects the unit to the antenna feedline. Construction and drilling details are shown in Fig. 4.

The author used a six-prong power plug (Cinch-Jones P-306-AB) on his unit to match an existing cable from his receiver. A three- or four-prong power plug can be used if desired. Also, if the builder prefers, phono jacks can be substituted for the coax antenna jacks—though coax jacks are recommended for high-frequency use to avoid losses and to insure adequate shielding.

The 6C4 is mounted on a small aluminum bracket (see Fig. 4) fastened to the bottom of the Minibox. The bracket is set at an angle



MATERIALS LIST—ELECTRONIC ANTENNA RELAY

Desig.	Description
C1	.01 mfd. 1.6 Kv disc ceramic or mica capacitor
C2, C3, C5, C6	.01 mfd. disc ceramic capacitors
C4	.001 mfd. disc ceramic capacitor
J1	Coaxial chassis jack and plug (Amphenol 83-1R and 83-1SP or equivalent)
J2	miniature coaxial chassis jack and plug (Jerrold C-52 and C-61 or equivalent)
NE-2	NE-2 neon bulb
R1	470,000 ohm, 1/2 watt resistor
RFC1	2.5 mh, 125 ma RF choke (National R100 or equivalent)
RFC2	2.5 mh, 125 ma RF choke (National R100 or equivalent)
PL-1	Cinch-Jones 6, 4, or 3-prong chassis plug with matching socket
V1	6C4
1	9-pin miniature Bakelite or ceramic tube socket
1	miniature feed-through insulator, RF type
1	Bud CU 2102A Minibox, 2 x 1 1/2 x 4"
Misc	RG-58/U or RG-59/U coaxial cable (see text), 1 pc 1/16" aluminum, 2 x 2"; twelve 6-32 x 1/4" machine screws; nuts; solder lugs, etc.

to facilitate tube removal and to allow room for the power plug and associated components. It is important that the tube socket be Bakelite or ceramic to give good RF insulation.

For proper operation, it is also important to minimize capacitive coupling between the input and output sections of the circuit. The extra plate lug on the tube socket (pin 5) should be clipped off and pin No. 1 positioned to solder directly to a small feed-through insulator at the top corner of the tube bracket. If the relay is to be used on lower frequency bands only, a simple insulator can be made by passing a machine screw through a small rubber grommet. For high frequencies, the insulator should be a low-loss RF type.

The components in the input of the circuit, C1, C2, C3, R1 and RFC1, are mounted beneath the tube socket. The output components are mounted on the power plug side of the tube bracket. The tube mounting bracket acts as a shield between the input and output of the relay.

Choke RFC1 should be self-supporting, about 1/4 in. away from the sides of the cabinet. Choke RFC2 is insulated with a layer

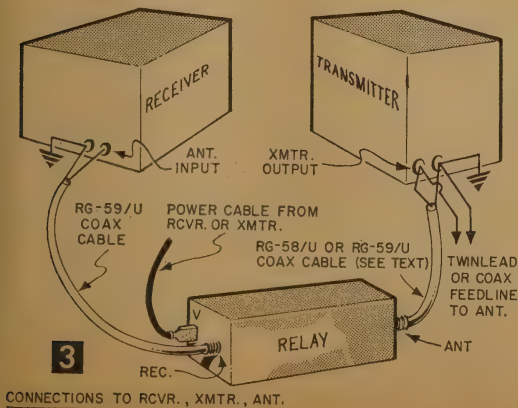
of tape or gummed paper to prevent accidental contact with the chassis and other components. Connect C3 from pin 4 of the tube socket to ground; C5 and C6 from their respective power socket pins to ground. These capacitors bypass any RF on the power cable to ground.

Power requirements for the relay are 6.3 v at 150 ma for filament supply, and from 150 to 250 v at about 25 ma for the plate. These voltages are obtainable from most amateur receivers and transmitters. Check the schematics of yours.

The relay is designed to work into an unbalanced transmission line (one lead grounded, the other hot), since most modern transmitters feature this type of output. If the antenna impedance is in the vicinity of 53 ohms, connect the relay to the antenna with type RG-58/U coaxial cable. Type RG-59/U coax can be used for ribbon or coaxial feedlines having impedances from 70 to 300 ohms. The cable from the relay to the receiver should be RG-59/U coaxial cable. In each case, the outside conductor of the cable is connected to the grounded antenna terminal, the inner conductor to the above-ground terminal.

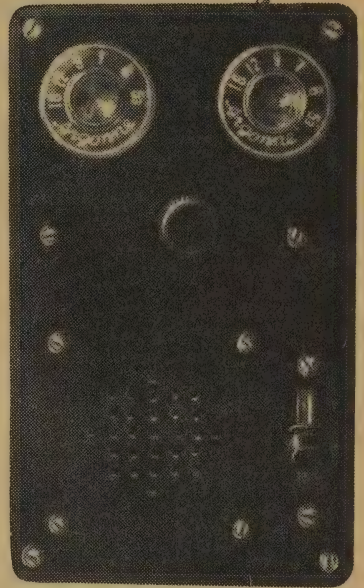
The lead between the T-R Switch and the receiver should be as short as possible. The lead to the antenna can be as long as 3 ft. without noticeable effect and can be connected to the output terminals of the transmitter if a low-pass filter is not used in the transmission line. If a filter is used, connect the relay to the antenna side of the filter. With transmitters having coax output jacks, it is best to install a second jack in the transmitter for the relay and to make feedline connections inside the transmitter cabinet. This will reduce unwanted radiation and facilitate the use of different antennas if the transmitter is operated on more than one band.

Test the relay by first loading the transmitter to the antenna and then connecting the



A Portable Wireless Intercom

By FORREST H. FRANTZ, Sr.



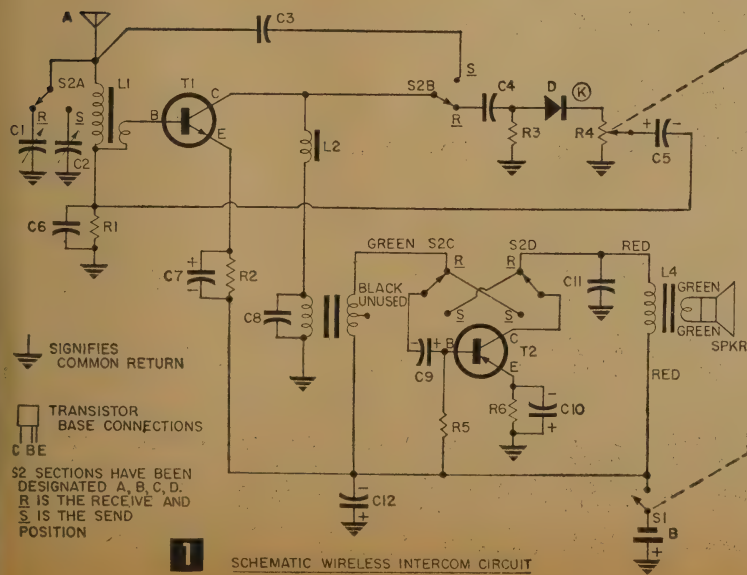
A neat, compact, two-transistor device, this portable intercom also functions as a broadcast band receiver.

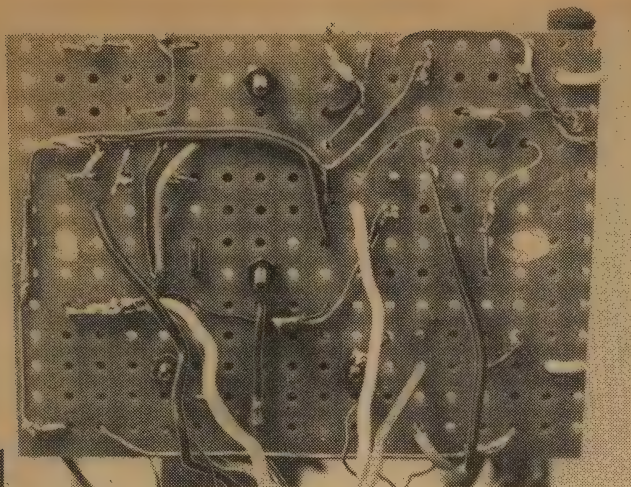
This transceiver makes an excellent week-end construction project. It does not require a license!

THERE'S no need to be stuck with intercom stations at fixed locations in your home. This portable wireless intercom can be carried wherever you wish to use it. It operates in the

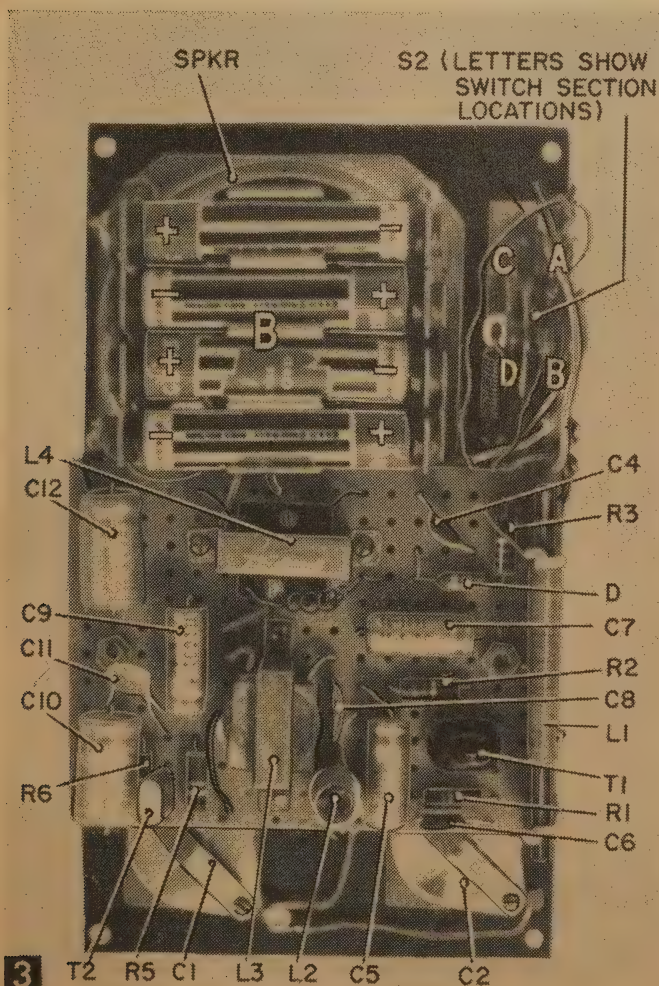
broadcast band under FCC limited radiation rules, and therefore does not require a license (limit communication distance to 75 ft.), and the receiver can be used for BCB reception. Components will cost between \$10 and \$15. For two-way communications, of course, you need two units. But with one unit you can indulge in one-way communication by using a broadcast receiver as the second station.

Trouble-Free Construction. The leads connecting to the Send-Receive switch, and those in the RF portion of the unit should be kept short and direct. When construc-





Circuit board wiring.



Parts call-out in case.

tion is completed, you may have to redress them to eliminate oscillation. First, remove antenna coil L1 from its Masonite mounting strip. Then cut shaft of volume control R4 to a length of $\frac{1}{4}$ in. Then turn connection of battery holder lugs over with pliers to form series connections and solder (see Fig. 3). Fill contact eyelets with solder.

Jumble-wind coupling coil L2 from 25 ft. of 7/41 litz wire on $\frac{3}{4}$ -in. length of $\frac{1}{4}$ -in. dia. ferrite core. Leave $1\frac{1}{2}$ in. connecting leads. Apply a coat of Duco cement to hold the windings in place. Clean and tin the ends of the leads.

Drilling and Cut-Outs. The circuit board as purchased is cut to correct size. Holes must be drilled in it as shown in Fig. 4. The front panel as purchased is cut to correct size and contains the four corner holes required to fasten it in the case. The other hole and switch cut-out locations are shown in Fig. 5. The cut-out for the Send-Receive switch is made by drilling a series of adjacent holes, finished with a keyhole saw and a file. The hole in the case for mounting the antenna is $\frac{9}{32}$ in. dia. placed 1 in. from the front and 1 in. from the right-hand side on the top of the case.

Front Panel Component Mounting. Mount C1 and C2. The dials are removed by loosening the knurled decorative head screws. These capacitors, because of their compact construction, sometimes develop shorts. Connect an ohmmeter across each of them in turn and rotate the shafts. If either of the capacitors is shorted, send it back to the supplier for replacement. *Don't attempt a repair.*

Mount the volume control (R4), the Talk-Listen switch (S2) and the loudspeaker (SPKR). Place the knob on R4 and the handle on S2. Fasten the 1-in. machine screws (which hold the circuit board in the final assembly) to the front panel.

Circuit Board Wiring. Mount transformers L3 and L4, and mount the antenna coil L1.

Fasten the coil with insulated hook-up wire or cord passed through the circuit board and tied around the coil. A few drops of Duco cement will hold it in place.

Using Figs. 1, 2, and 3 for guidance, wire the circuit board. Mount the components as required in the progress of the wiring. Note that most of the component pigtails pass through the circuit board. The pigtails are bent over and soldered together to form the circuit wiring. This produces a neat job, permits you to make short connections, and makes the compact size of the unit possible.

The leads which are to be connected between the circuit board and the panel wiring of the circuit board should be connected during the wiring of the circuit board. Leave these leads about 6 in. long and cut to length later when the wiring board and panel assemblies are integrated. Use wires of different colors and keep a record of the code to make integration of the circuit board and front panel easier.

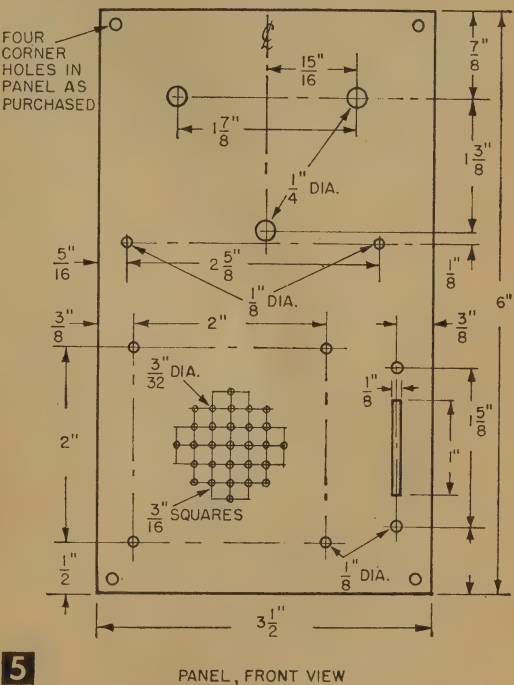
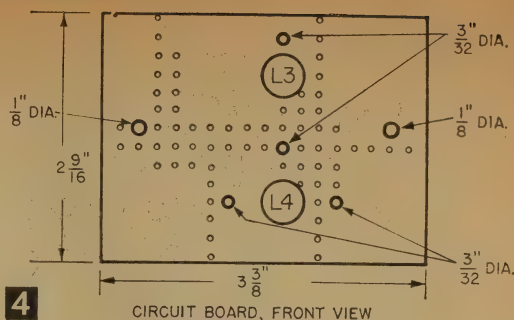
Front Panel Wiring. Wire R4-S, C1, C2 and the portion of the S-2 connections that do not tie into the circuit board wiring. The gimmick C3 is simply a piece of hook-up wire connected to S2 and twisted loosely around the lead from S2 to C2. Wire insulation acts as the dielectric. In making connections to S2, be careful to avoid bending or exerting undue pressure on the switch contacts and lugs. Also be cautious about exerting pressure on the switch wafer.

Mount the circuit board on the 1-in. machine screws provided on the front panel for this purpose. The nuts near the ends of these screws (Fig. 2) should be adjusted for correct spacing of the mounting board from the panel. Be sure that there aren't any shorts between the switch S1 and the circuit board. The lugs of S1 may have to be bent slightly to the side.

Make the interconnections between the front panel and the circuit board. The secondary of L4 connects to SPKR and several leads from the circuit board connect to R4-S1 and S2.

Mount the battery holder on the speaker magnet frame by passing a loop of wire around the holder and frame on each side of the magnet. Twist the ends together on the bottom side. A drop of Duco between the speaker and the battery holder will tend to make the mounting more solid. Connect the battery holder into the circuit. Insert the batteries in the holder, observing correct polarity. Then provide a lead from S2A to the antenna and place the assembly in the case. But don't fasten the four panel holding screws yet.

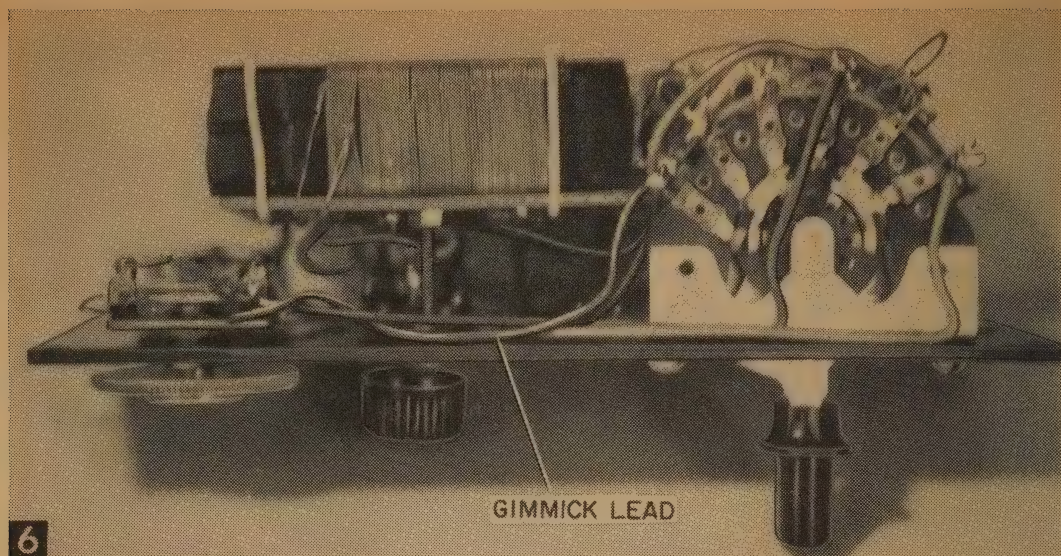
Testing Operation. Turn switch S1 on and turn R4 clockwise for maximum volume. Tune C1 to a local broadcast station. If you can't pick up a station, extend the antenna. If you still can't pick up a station (assuming



you're within 5 miles of a 250-watt station or within 10 miles of a 5 KW or more powerful station), recheck the wiring. Incorrect positioning of the S2C and S2D leads may cause audio feedback. To cure consistent squealing and whistling, redress these leads.

When you have broadcast reception, remove the set from the case and move the position of the lead on the antenna end of L1 relative to C4 for maximum gain at the high-frequency end of the broadcast band. Then decrease the volume control setting to about half of full setting. If the set squeals, decrease the coupling between the L1 lead and C4 till squealing quits.

Turn a broadcast receiver on and tune to a frequency at which you don't receive a broadcast station. Then, from a position near the receiver, with the intercom on and the antenna pushed down, push S2 to the send position. Adjust C2 till the intercom carrier comes in on the broadcast receiver. The



Side view of front-panel mountings.

coupling of gimmick C3 may have to be increased to attain a signal or decreased to minimize squealing and distortion at the receiver. Audio feedback due to coupling between intercom and receiver causes squeals also—but occurs only when receiver and intercom are within audible “hearing” distance.

The antenna may be extended to increase range, but don't open it far enough to permit reception beyond 75 ft. The intercom will function best for communication when held upright with the antenna vertical. It will function best as a broadcast receiver when the antenna loop is horizontal. It is extremely directional and selective in this plane.

Operating Principles. The remote wireless intercom is an intercom that permits talk-and-listen operation with another unit without requiring connecting wires. The speaker functions as mike and speaker. Separate talk and listen tuning controls permit tuning to any desired frequency with easy switching from talk to listen without having to retune. To receive, C1 must be set for the frequency that C2 of a second intercom is tuned to in order to receive it. It is best to tune the two intercoms and then lock the capacitors. Don't depend on dial calibration to do the job.

The wireless intercom employs only two transistors and one diode. In the listen function T1 acts as an RF amplifier, and diode D1 rectifies the signal to provide an audio voltage signal. This signal is fed back through T1 which amplifies the signal again. Then the signal progresses to output stage T2 and the loudspeaker. The receiving circuit achieves considerable gain and selectivity with minimum equipment through the use of good components and the exercise of design innovations.

On the talk function, the coupling from the collector of T1 to the antenna and base of T1 is increased by C2 to produce broadcast frequency oscillation. The input and output connections to T2 are changed by S2 to make the speaker function as a mike and to make T2 function as a modulator for T1.

MATERIALS LIST—WIRELESS INTERCOM

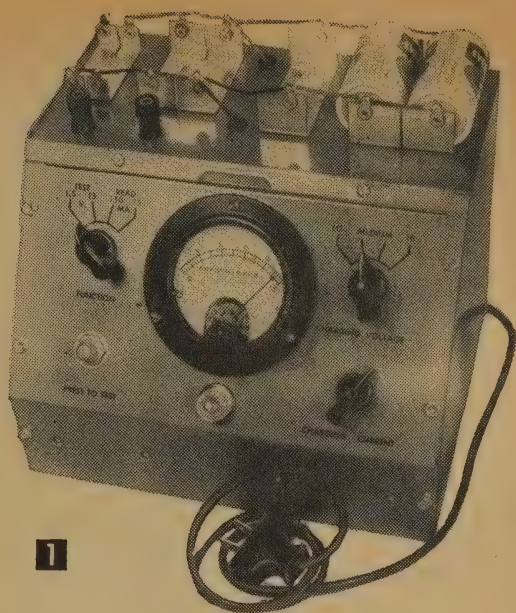
Desig.	Description
R2, R6	270 ohm, 1/2 watt carbon resistor, 10%
R3	33K, 1/2 watt carbon resistor, 10%
R5	100K, 1/2 watt carbon resistor, 10%
R1	270K, 1/2 watt, carbon resistor, 10%
R4-S	10K miniature volume control with switch (Lafayette VC-28)
C3	gimmick (see text)
C4	100 mmf., 1000 v. ceramic capacitor (Sprague 5 GA-T1)
C6, C8, C11	.01 mfd., 50 v. ceramic capacitor (Sprague TG-S10)
C5, C7, C9	25 mfd., 6 v. miniature electrolytic capacitor (Sprague TE-1091)
C10, C12	100 mfd., 6 v. miniature electrolytic capacitor (Sprague TE-1102)
C1, C2	365 mmf. miniature variable capacitor (Lafayette MS-445)
T1	2N168A transistor (General Electric)
T2	2N407 transistor (Sylvania)
D	1N66 diode (Raytheon)
S2	4P2T spring return lever action switch (Centralab 1457)
L1	ferrite antenna loop coil (Miller 2004)
L2	25' 7/41 litz wire wound on 3/4" length, 1/4" dia. ferrite core. (Lafayette MS-331 is a 7 1/2" length of ferrite core and Belden 8817 is a 100' length of the wire)
L3	10K to 2K miniature driver transformer (Lafayette TR-96)
L4	2K to 10 ohm miniature output transformer (Lafayette TR-93)
SPKR	10 ohm, 2 1/2" loudspeaker (Lafayette SK-66)
A	miniature telescoping antenna (Lafayette F-343)
B	four 1.5 v. penlite cells, series connected (Burgess No. 7)
	battery holder (Lafayette MS-170)
	miniature knob (Lafayette MS-185)
	2 7/16 x 3 3/8" miniature perforated circuit board (Lafayette MS-304)
	2 x 3 3/4 x 6 1/4" Bakelite case (Lafayette MS-216)
	front panel for case (Lafayette MS-217)

Components for this project may be obtained from Lafayette Radio, 100 6th Avenue, New York 13, N. Y.

Dry Battery Tester-Charger

A single unit to test and charge flashlight, transistor radio and other small batteries

By W. F. GEPHART

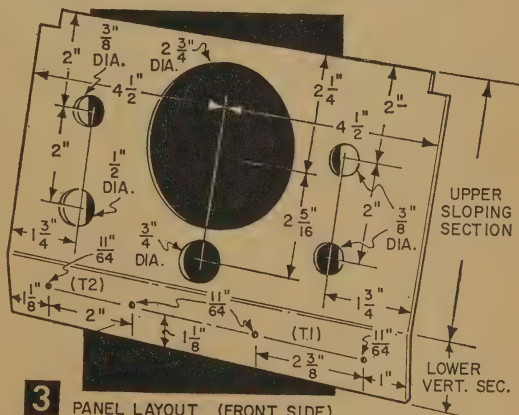


1

Overall view of charger. Battery clip arrangement may be varied to meet individual needs.

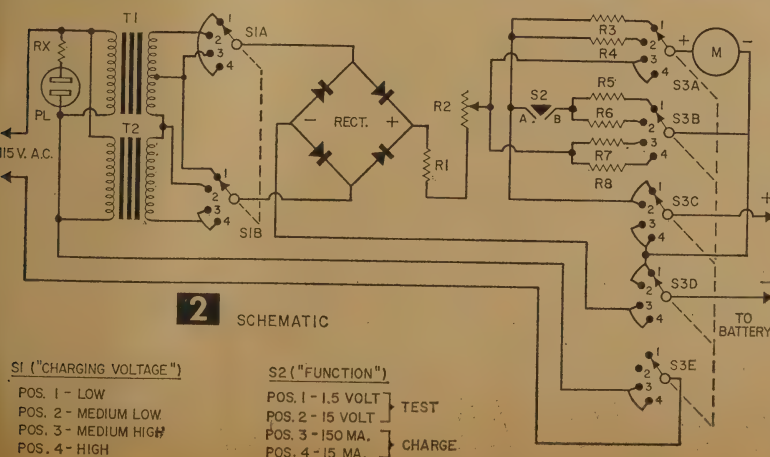
RECHARGING or boosting small dry batteries can be worthwhile if you have several flashlights, battery radios or other battery-powered equipment. Properly used, a charger can triple or quadruple the life of batteries, making the investment in a charger worthwhile. The unit shown in Fig. 1 also includes a tester to show when "recharging" is desirable. (Since dry batteries are essentially primary cells in which a chemical reaction takes place, true recharging is not possible. However, rejuvenation, which will extend the life of the cells, is possible. We'll call this recharging.)

Recharging must be done before the battery is completely exhausted. New batteries usually read about 1.5 v per cell (without load) on the average meter. Under normal load (about 25 ma for a battery made up of penlight cells, and about 150 ma for the larger flashlight batteries) the voltage of a fresh cell should not drop more than 10%. Thus, a type "D" flashlight battery in top condition ought to test at 1.5 v or better without load, and not less than 1.35 v with a 150



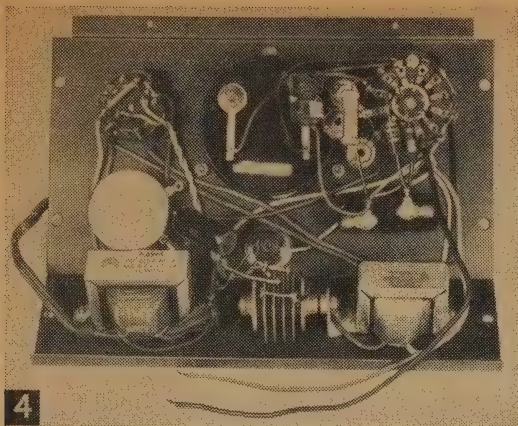
3

PANEL LAYOUT (FRONT SIDE)



ma load. When it drops below these levels, it should be recharged. Recharging is not too effective when the voltage (with or without load) is below two-thirds of the new-condition voltage.

Bear in mind, too, that the battery must be placed in service promptly after recharging. The shelf life of recharged batteries is short (probably due to the limited chemical action that takes



4 Inside view of unit. All parts are mounted on back of front panel.

MATERIALS LIST—BATTERY CHARGER

Desig.	Description
Rx	56K, 1/2 watt (required only if not included in PL)
R1	20 ohm, 1 watt
R2	200 ohm, 4 watt potentiometer (Mallory M200PK)
R3	1500 ohm 1% precision (see text)
R4	15K 1% precision (see text)
R5	10 ohm, 1/2 watt
R6	330 ohm, 1/2 watt
R7	.66 ohm 1% precision (see text)
R8	7.14 ohm 1% precision (see text)
S1	two-pole, 4-position rotary switch (Mallory 3226J)
S2	SPST push button, normally open
S3	five-pole, 4-position rotary switch (Mallory 1335L)
T1	6.3v CT 1 amp filament transformer (Merit P-2944)
T2	6.3v 1/2 amp filament transformer (Merit P-2964)
Rect.	bridge-connected selenium rectifier: a-c input—15 v maximum, at 200 ma (Federal 1016)
PL	pilot light holder for NE-51 lamp (Dialco Series 95408X and 942208 have built-in resistor Rx)
M	0-1 milliammeter
	Steel cabinet, 6 1/2 x 7 1/4 x 9" (Bud C-1585), NE-51 lamp, 3 knobs, 2 binding posts, battery holders as desired, line cord, miscellaneous hardware

place). Even so, the drop in voltage after charging is the greatest in the first 24 hours.

No one seems quite sure what actually happens in dry battery recharging, and some experimenters claim the best results with *ac* charging voltages, some with *dc*, and some with a combination. This unit uses unfiltered, fluctuating *dc*, which seems to give the best results in the shortest time. Filtered *dc* (secured by placing a large capacitor across rectifier output) seems to give about the same results, but requires a charging time of 12-20 hours.

Here are some results with unfiltered *dc* and an hour's charging time:

Type Battery & Service		Before Charge	Immediately After Charge	2-5 Days Later*
Two "D" Cells (Flashlight)	No Load	1.35 v	1.52 v	1.40 v
	Load	1.20 v	1.37 v	1.35 v
Three "D" Cells (Strobelight)	No Load	1.33 v	1.40 v	1.35 v
	Load	1.15 v	1.33 v	1.30 v
Two "C" Cells (Flashlight)	No Load	1.35 v	1.60 v	1.45 v
	Load	1.15 v	1.50 v	1.35 v
9 v Transistor# (Radio)	No Load	7.5 v	8.7 v	8.0 v
	Load	2.0 v	7.2 v	6.0 v

* shelf life time; not in service

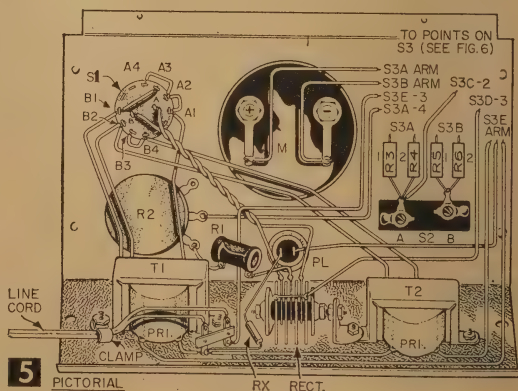
charged at 9 ma; all others charged at 100 ma

We see that particularly in the case of the transistor battery, recharging is not too effective when the battery nears exhaustion. The charging rate must be fairly low, with a range of 5-30 *ma* recommended for batteries made up of penlight cells, and a range of 50-200 *ma* for the larger cells, such as "C", "D", and "A" cells.

Schematic Fig. 2 shows that switch *S*₃ controls the function of the unit. On Positions 1 and 2, used for testing, proper meter multipliers are switched into the circuit for reading the battery voltages, and load resistors are cut in by pressing switch *S*₂. When switch *S*₃ is on Positions 3 and 4, *ac* power is on, and the *dc* output is fed through the meter (with proper current shunts) to the

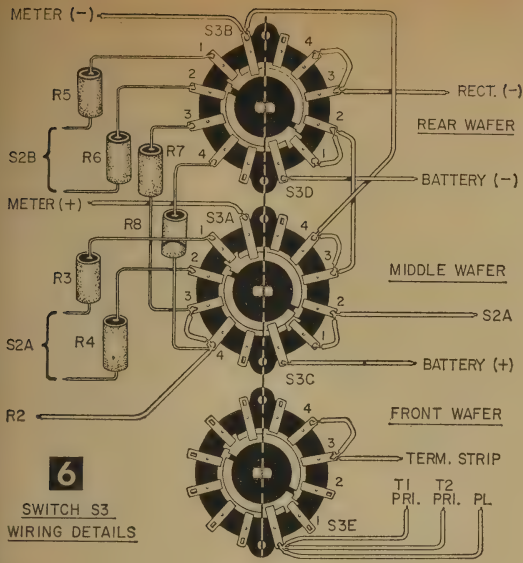
battery, with terminal polarity reversed. The proper charging voltage and current is selected by switch *S*₁ and rheostat *R*₂. Two filament transformers, with their secondaries wired in series through *S*₁, provide *ac* input voltages to the rectifier of 3.15, 6.3, 9.45, and 12.6, which are sufficient for all batteries up to 9 volts. Resistor *R*₁ is a limiting resistor to prevent the current from reaching excessive levels.

All parts (except battery holders and terminals) are mounted on the front panel of a small sloping-front cabinet, as shown in



Figs. 4 and 5. The layout for the panel is shown in Fig. 3, except for the meter mounting screw holes, which should be drilled to fit the meter being used.

The values shown for resistors *R*₃, *R*₄, *R*₇ and *R*₈ are applicable only to a 0-1 *ma* meter with an internal resistance of 100 ohms. This is a standard 1000 ohms/volt movement, but values for other meter movements can be calculated with the formulas top of opposite page for the ranges shown on Fig. 2:



$$R3 = \frac{15 - (I_m \times R_m)}{I_m} \quad R4 = \frac{15}{I_m}$$

$$R7 = \frac{I_m \times R_m}{.014} \quad R8 = \frac{I_m \times R_m}{.150}$$

I_m is the full scale deflection of meter in amperes, R_m is the internal resistance of meter in ohms.

Wire the primaries of the transformers and pilot light first. Then check polarity of the

secondary leads of the transformers so that series wiring will give 12.6 v. If the polarity is incorrect, the two secondaries will buck each other, and give no output voltage when wired in series. Complete the wiring.

The selection of the number and types of battery holders mounted on the cabinet will depend on individual needs. Two binding posts, wired in parallel with the battery holders, are also provided. Several sets of leads, using the most often needed battery plugs can then be used with the binding posts for those batteries that do not fit in the holders.

To use the unit, plug it in, turn S_1 to "Low", R_2 to full counterclockwise position, and S_3 to "15V Test." Put the batteries in the proper holder (or attach to leads), and switch S_3 to the appropriate scale and read the no-load voltage. Then press S_2 to read the voltage under load. Resistor R_5 provides a 150 ma load with 1.5 v, and R_6 provides a load of about 14 ma at 4.5 v, 18 ma at 6 v, and 27 ma at 9 v. Next, switch S_3 to the desired charging current range, and set the charging rate by adjusting S_1 and R_3 .

Generally, charging for an hour or two at the rates mentioned above will be effective. The rate may be increased, but under no conditions should the battery be permitted to get warm. Longer charging times can be used, with varying effectiveness, depending on the charging rate and battery condition, but the unit should be watched. Sometimes excessive charging, either in current rate or time, seems to break the cell down, and the current rises, increasing the damage.

Unscrewing the Inscrutable

Those Darn Decibels!

by Ol' Rock

Few terms are as frequently misused or widely misunderstood in electronics as is the *decibel*.

The decibel system merely *compares* signal power levels. Properly used, it makes possible a great simplification of arithmetic.

Decibels can be used to compare any two signal power levels of the same kind, in either an acoustical or electrical system. Or, one may compare the power of a given signal with a previously agreed-upon standard. When the signal being considered is compared to a similar, hypothetical, one-milliwatt signal, we speak of the "level" of the signal concerned, in DBM. Further, one may compare, in decibels, the strength of a given signal to that of the noise power in the same system—the "signal to noise ratio."

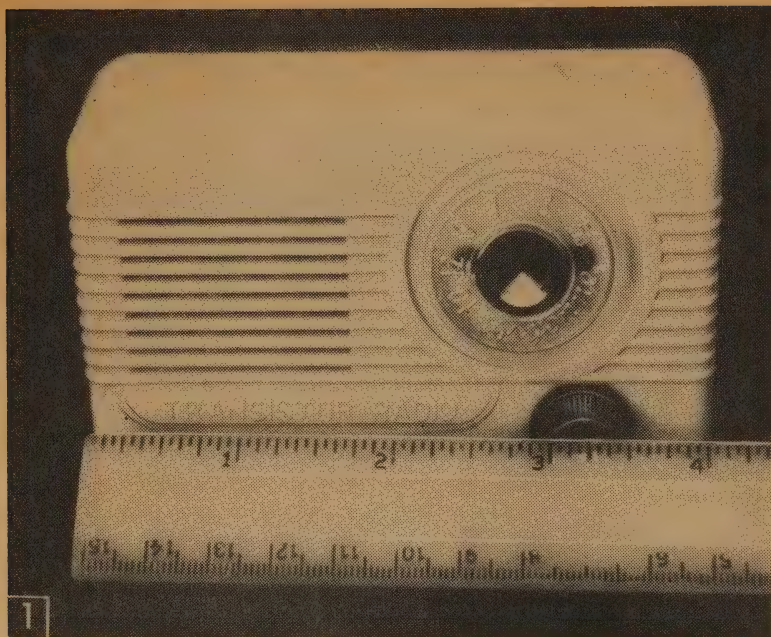
Let's get straight on the basic facts: First, the decibel measures *ratios*, that is, how many times greater or less-powerful is the signal concerned, as compared to the reference signal. Second, decibels are not measured upon an ordinary arithmetical scale, but rather upon what engi-

neers call a *logarithmic* scale. This is perhaps the most confusing point to the uninitiated. Twice as many decibels do *not* mean twice as strong a signal, for instance. Here's how a decibel scale works:

Ratio of Signal Power	DB Greater	DB Less
Signal powers equal	0 DB	0 DB
First signal twice as strong, or one-half as strong as the other	+3 DB	-3 DB
First four times as strong or weak	+6 DB	-6 DB
First ten times stronger or weaker	+10 DB	-10 DB
First 100 times greater or less	+20 DB	-20 DB
First 1000 times greater or less	+30 DB	-30 DB
First one million times greater or less	+60 DB	-60 DB

Any good electrical engineering reference book will show you how to obtain decibel values or corresponding power ratios for the intermediate values, such as -36 DB, +57 DB, etc.

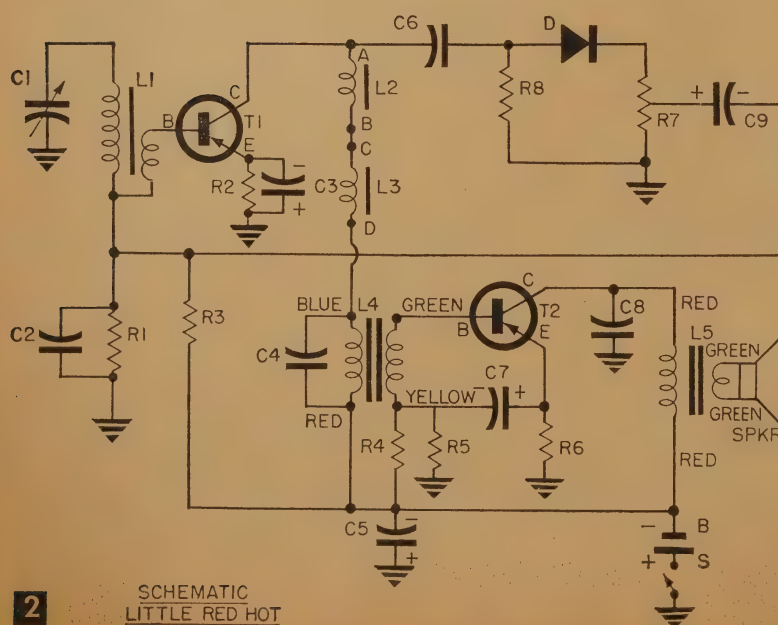
A convenient feature of the decibel system is that amplifier gains and circuit losses, when each is expressed in DB, may be added and subtracted by simple arithmetic directly, to evaluate simply the performance of an entire communication system.



The Little Red Hot

This compact, attractive reflex receiver is so small it fits easily into pocket or purse

By FORREST H. FRANTZ, Sr.



SCHEMATIC
LITTLE RED HOT

A set that's small but one that will scoop up rock 'n' roll from local broadcasters, commercials and all.

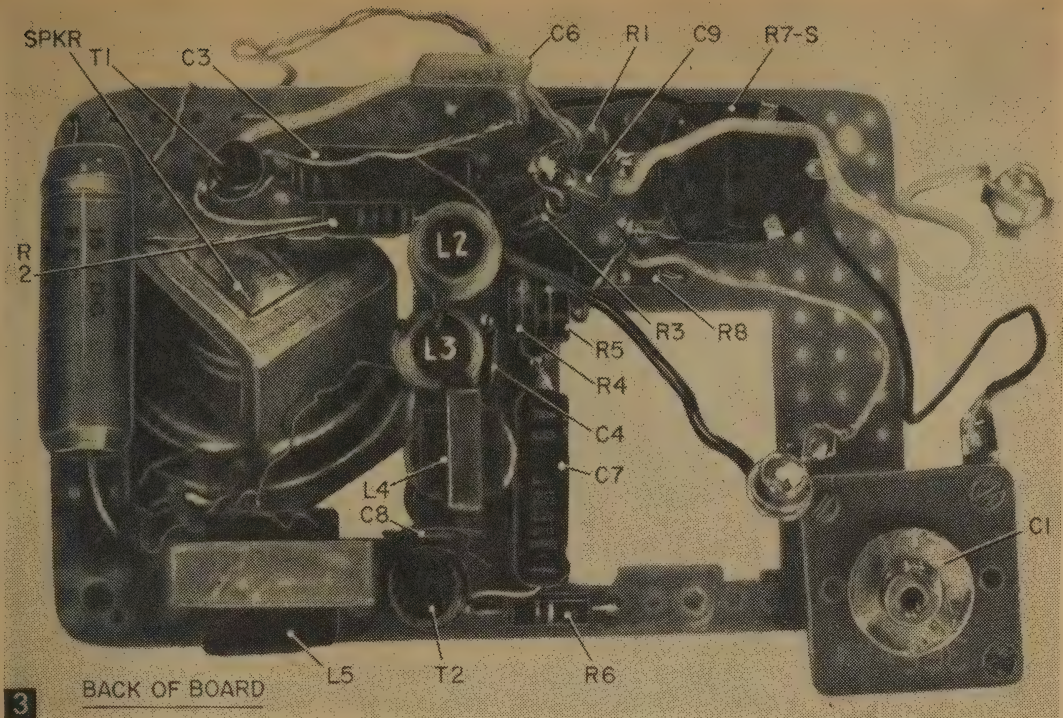
To get plenty of gain in the Little Red Hot transistor T1 (see Fig. 2) amplifies the signal twice, once while it is still RF and then again when it is AF after detection by diode D. The audio output of T1 is introduced to the base of transistor T2 through the audio driver transformer L4. The impedance match between T1 and T2 provided by L4 affords considerably more gain than you could expect from resistance-capacitance coupling.

Though not apparent from the circuit, and though not enough to make the set oscillate, there is positive feedback in the RF stage, resulting from the relative placement of the components in the case. This feedback feature and the high Q of the antenna coil (L1) make the set quite selective in spite of the fact that it has only one tuned circuit.

Cost of the components for the Little Red Hot will be a little over \$15. Construction time will vary with the builder's experience, but the compact construction makes this project a delightful experience in miniaturization.

Construction. The construction of this receiver may be accomplished most efficiently by pursuing the task in these phases:

- 1) Adapt parts.
- 2) Make the circuit board.



Back view before assembly.

- 3) Mount parts.
- 4) Wire the circuit board.
- 5) Complete wiring and assemble.
- 6) Test, adjust and debug.

Begin by cutting the volume control shaft to a length of $\frac{3}{8}$ in. Place the portion of the shaft to be eliminated in a vise and cut with a hacksaw. Now remove antenna coil L1 from its Masonite mounting board. Replace the paper tape around the coil ends to hold and protect the windings.

Make coils L2 and L3 using the data shown in the Materials List. Coat these coils with Duco cement to prevent unwinding of the turns.

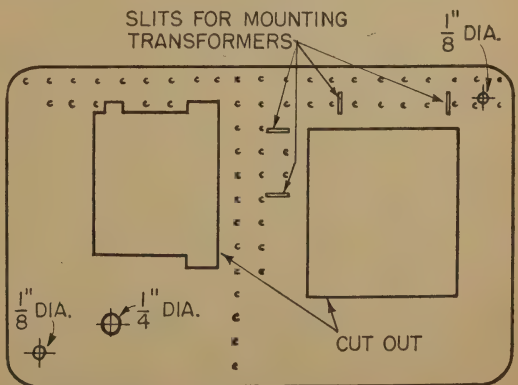
The number of turns is not too critical, so if you slip a bit in counting them, don't worry about it.

Next, place two layers of cellophane tape about $\frac{3}{8}$ in. wide around the edges of the speaker frame on the back of the speaker to prevent the speaker frame from shorting some of the receiver wiring which it would otherwise touch.

The circuit board is cut from a miniature perforated board according to the layout shown in Fig. 4. Speaker and tuning capacitor cut-outs are made by using the hacksaw blade removed from the saw frame. Starter holes can be made with drill and taper reamer. The slots for the transformers (L4 and L5) are also made with the hacksaw blade. Drill a $\frac{1}{8}$ -in. starter hole for the volume

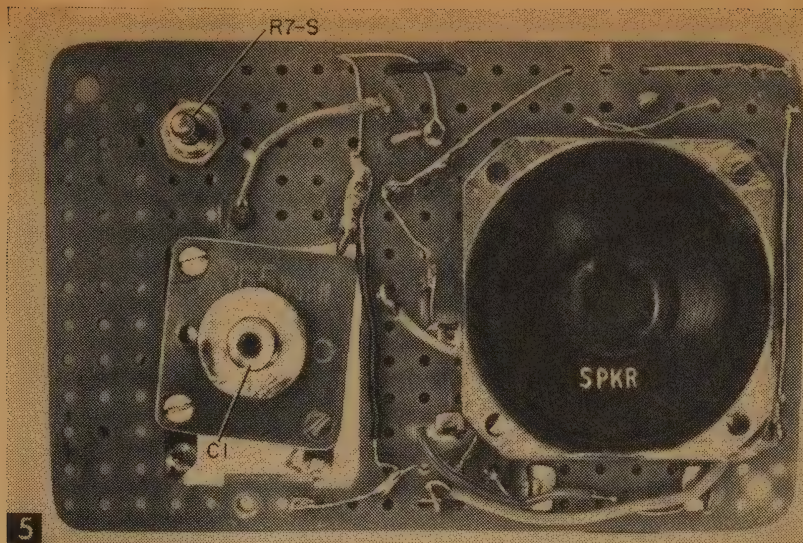
control shaft and ream to size, or simply drill using a $\frac{3}{8}$ -in bit. When cutting and drilling is completed, dress the edges of the board and the cutouts with a file.

Use Fig. 3 as a guide for mounting parts. Mount volume control-switch R7-S and transformers L4 and L5 first. The transformers are mounted by bending their mounting lugs down 90° so they can be inserted in the circuit board slits. With the transformer mounting lugs inserted in the circuit board slits, press the transformer against the board, and bend the lugs over on the front of the circuit board. Duco cement placed between the base



4

CIRCUIT BOARD LAYOUT—BACK VIEW



Front view of circuit board.

of the transformers and the circuit board will stabilize the mounting and may bail you out if you break a transformer lug in the mounting process.

Mount L2 and L3 by fastening with Duco cement, but go easy on the cement because you may have to loosen and re-orient these coils. The remaining components are mounted in the process of wiring the circuit board.

MATERIALS LIST—LITTLE RED HOT

Desig.	Description
	1/2 watt carbon resistors, 10% tolerance
R6	100 ohms
R2	470 ohms
R5	2.7K
R1	10K
R4, R8	15K
R3	47K
R7-S	10K miniature volume control with switch (Lafayette VC-28)
C6	100 mmf. Mini Kap ceramic capacitor (Lafayette DM-101)
C2, C4, C8	.01 mfd. 75v. subminiature capacitor (Lafayette C-612)
C9	1 mfd., 6v. subminiature electrolytic capacitor (Lafayette P6-1)
C3, C7	30 mfd., 6v. miniature electrolytic capacitor (Lafayette CF-104)
C5	100 mfd., 15v. miniature electrolytic capacitor (Lafayette CF-126)
C1	365 mmf. miniature tuning capacitor (Lafayette MS-445, includes tuning dial)
L1	flat ferrite antenna loop coil (Miller 2004)
L4	10,000 ohm to 2,000 ohm subminiature transformer (Lafayette TR-98)
L5	2,000 ohm to 10 ohm miniature output transformer (Lafayette TR-93)
L2, L3	Coils L2 and L3 are jumble-wound with Belden 8817 litz wire on 1/4" dia. ferrite cores (saw or break off of Lafayette MS-331). Wind 25' of wire on a 3/4" length of core for L2, and 15' on 1/2" of core for L3
T1	2N412 transistor (RCA)
T2	2N321 transistor (GE)
D	1N60 diode (Raytheon)
SPKR	1 1/2" PM loudspeaker (Lafayette SK-61)
B	9v. transistor radio battery (Mallory TR-146R) volume control knob (Lafayette MS-185) miniature perforated board (Lafayette MS-305) case (Lafayette MS-424 ivory or MS-427 maroon)

All components for this project are available from Lafayette Radio, Dept. SM, 165-08 Liberty Avenue, Jamaica 33, New York.

The circuit board is wired by inserting component pig-tails through the perforations and making connections on the front of the board. Where several component pig-tails form a common junction, the pig-tails may be inserted in a common perforation. The connection routes on the front of the board are short enough in most cases to permit direct connection with component pig-tails.

Solder the connections as you go

along. Use a hot clean iron and rosin core solder. Solder quickly. Miniature components, particularly transistors and diodes, may be damaged by soldering iron heat applied for too long a time. Be cautious about electrolytic capacitor and battery polarities in making connections.

Mount T2 first and then wire C3, C7, R5, R6, R4, and C5 into the circuit. Then wire R3, R1 and C2. The connection of C4, L2 and L3 follows. Don't cut L2 and L3 leads too short; you may have to reverse connections later.

Next, mount diode D and connect C6, R7, R8 and C9 into the circuit. Mount T1 and complete connections to L2. Mount and connect R2 and C3.

Now recheck the wiring for correctness and examine the circuit board for poor connections and shorts. Then attach leads for C1 and for battery connections. Solder battery connection lugs on the battery leads, connect C1, and connect the L5 secondary leads to the loudspeaker voice coil lugs. Connect L1 into the circuit.

Whether it is best to place the Little Red Hot in the case or leave it out for test, adjustment and debugging is a tossup. If you don't place it in the case, care must be exercised to prevent shorting of components, and the tuning capacitor (C1) is difficult to adjust. If you place the receiver in the case, you'll probably have to pull it out if there are difficulties.

To test, adjust, and debug, connect the battery to the set (if it's available, use another less expensive 9-v battery—six series-connected penlite or flashlight cells are fine—for first tests), turn the volume on, and tune for a station. If the set is insensitive over the entire broadcast band, interchange the A and D

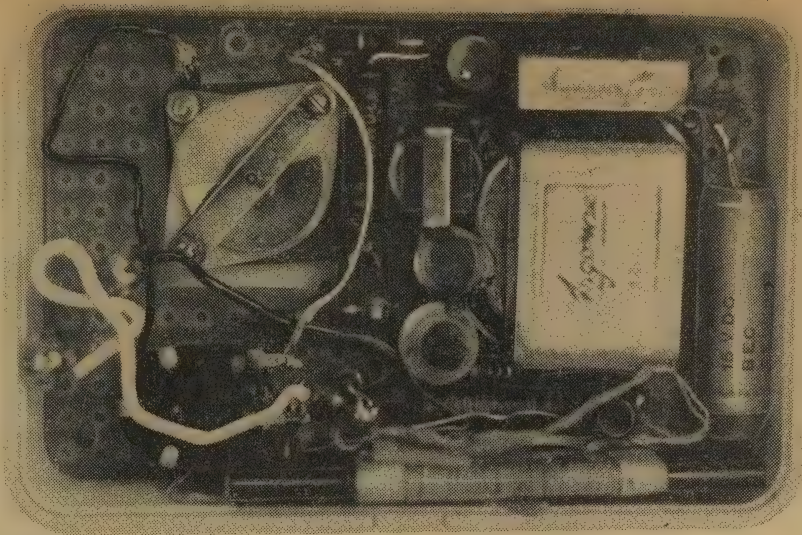
lead connections of L2-L3. Sensitivity should increase as L1 is moved toward the position approaching the "in-case" mounting relationship of L1 and L2-L3.

If the set is insensitive at one end of the band only, interchange L2's AB connections or L3's CD connections. Try the possible combinations till you arrive at the best results.

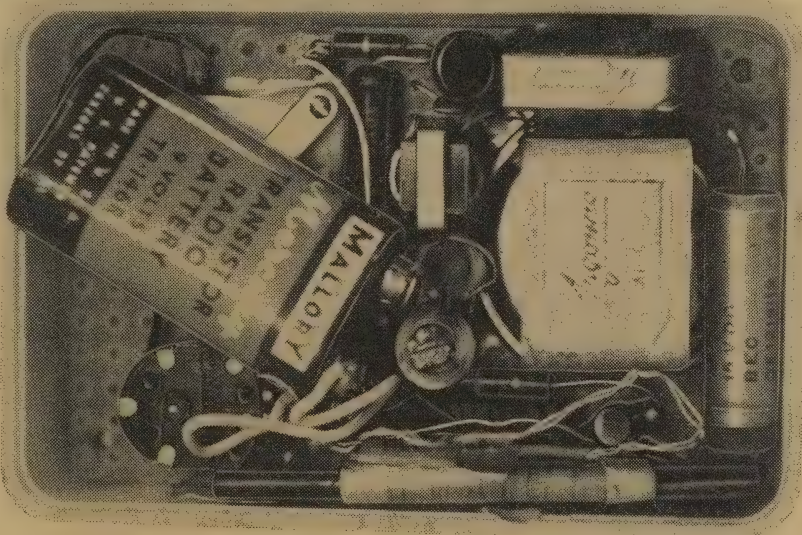
Next mount the set in the case and try it again. Slide L1 back and forth along the edge of the case till you get best sensitivity. It may be possible to reach a point where the set will oscillate (squeal). Simply change the position of L1 till the squealing stops.

The position of C6 relative to L1 influences sensitivity. The sensitivity of the set may also be increased by tilting L2 and L3 slightly from their vertical orientation relative to the circuit board if oscillations did not occur during the previous adjustment of the position of L1. Experiment with tilting to right and left with the set in the case. When optimum position is found, fasten L2-L3 in place permanently with cement, and fasten L1 against the side of the case with cellophane tape.

The circuit board assembly is held in the case with two machine screws. Pressure between the circuit board and the case holds the speaker in place. Position the speaker so that maximum cone area is visible through the cabinet speaker openings. Fasten C1 directly to the case with the two small machine screws provided with the capacitor for this purpose. Install the dial provided with the capacitor and fasten the volume control knob. Position the battery so the back of the case



6 A



B

Back view of entire assembly without (A) and with (B) battery.

can be snapped on. Insulate the battery lugs and any portion of the battery outer metal shell that might touch connections with cellophane tape.

The Little Red Hot will give you reasonable performance up to 10 or 15 miles from a broadcast station. It's extremely directive. A short (1 to 3 ft.) antenna lead connected to the junction of the C1 stator and the top of L1 will reduce this directivity.

Removing Enamel Wire Insulation

• To remove enamel insulation on magnet and hook-up wire quickly and cleanly, wrap a piece of sandpaper around the wire and give a twisting, rotary motion.—E. L. BURNER.

Underwater Intercom

This unusual intercom provides constant contact between boat and diver, amplifying your voice through a loudspeaker

By C. L. HENRY

DESIGNED for rough boat service or dockside operation, the amplifier of this intercom is transistorized for battery economy. Its simple circuitry and reliable operation make it ideal for Scuba divers, or even "hard hat" professionals.

The diver wears a throat mike and earphone (Figs. 1, 3). When he talks, his voice is amplified to speaker volume and can be heard by anyone within earshot on the boat or dock above. Unlike an ordinary telephone set, there is no push button or ringer, and the diver's hands are always free. Also, a special sidetone circuit enables him to hear his voice in the earphone and know that the surface is also hearing him.

At the "upstairs" end (Fig. 2) operation is ultra-simple, with a push-to-talk switch and

loudspeaker volume control as the only live controls. A separate volume control, R12, (Fig. 5B) is equipped with a Millen shaft lock so that the volume fed to the diver's earphone cannot be changed accidentally. Also, an auxiliary audio output jack enables you to connect in a remote speaker. One diver reported that this interphone, which uses less than \$20 worth of parts, paid for itself quickly in helping to salvage lost articles. It's fine for treasure hunting or coaching Scuba students and since the throat mike would enable it to work well in very noisy locations, it might have many uses on dry land as well.

Power for the microphone circuit is supplied by two D-size flashlight cells mounted inside the case. The 300-ma. amplifier requires an outside battery. You can use a lantern size dry cell, which will give you up to 15 hours of continuous operation, equal to many days of diving. Or, using the 6-12 volt selector switch, you can tap any convenient storage battery.

Construction. Begin by marking, drilling and punching all of the holes in the case, the front and back covers, Fig. 4 and in the internal chassis box (Fig. 6). Even though the case itself will be sealed later by rubber gaskets, it is necessary for salt water operation especially, to protect all metal surfaces against accidental wetting.

Coat the inside of the case and the surfaces of parts that you can't reach later with several layers of acrylic or silicone resin spray, which both insulates and provides corrosion resistance. Completely waterproof the speaker with 4 to 6 heavy coats of the plastic spray.

Wearing a waterproof earphone and throat mike, the diver is always in instant contact with the surface. The phone must be worn loosely to avoid unequalized ear pressure which could rupture the eardrum.





The diver's voice, at loudspeaker volume can be clearly heard on boat or dock. Man on surface presses push-to-talk button on top of amplifier case.

2

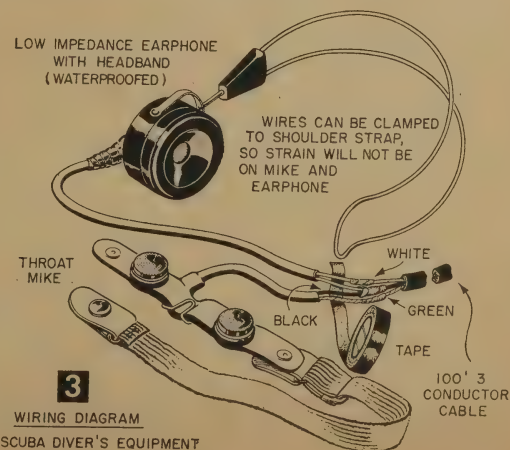
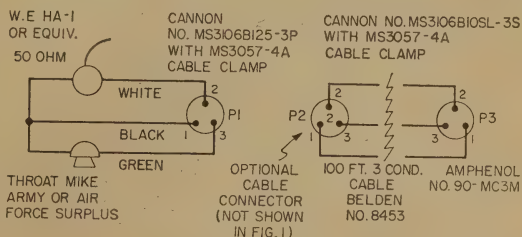
How It Works. In the amplifier, two transistors are used to obtain a full 2-watt output with a carbon mike input. Mike power is supplied by two flash-light cells mounted inside the amplifier case. They will provide months of use. The diver's carbon mike is connected through a transformer, T1, and volume control R4 to the input of the first transistor, TR1, a Syl- vania type 2N35. An NPN type, this transistor is operated in a common emitter type of circuit. Resistors R5 and R6 determine the bias or operating point of the transistor, and it requires about 4 ma collector current. The collector or output lead of the 2N35 is connected to the trans-

former T2. The winding of T2 is bypassed with C5 to correct the high frequency response of the amplifier. The secondary of T2 connects to the second transistor, TR2, a CBS type 2N155. Output of TR2 feeds to transformer T3 where the collector current

Next mount all the parts as shown in Figs. 5A, 5B, using lock washers or lock nuts. The transistors are located on the cover of a small 4 x 2 x 2 3/4-in. chassis box (Fig. 6) which in turn is mounted on the inside of the back panel of the amplifier case. Bolt the 2N155 transistor directly to the box, after scraping the box paint off to provide tight contact and effective heat dissipation.

Transformer T1 is mounted inside the chassis box along with the resistors and capacitors in the transistor circuitry. Positioning of parts is not critical, but keep the input and output circuits as far apart as possible, since feedback or whistling may occur if they are close enough to couple. Wire the transistor circuit (Fig. 5C) and then complete the rest of the amplifier, using color coded hook-up wire.

Now check your wiring carefully against the schematic. If the transistors are wired incorrectly, they will be ruined instantly when power is applied to the circuit. Complete construction by lacing the wiring carefully, and then coat the entire assembly (switch contacts protected temporarily with tape) with the waterproofing sprays mentioned earlier. Cut strips of rubber and cement them to the case to make a water-tight gasket for the front and back panels.



3

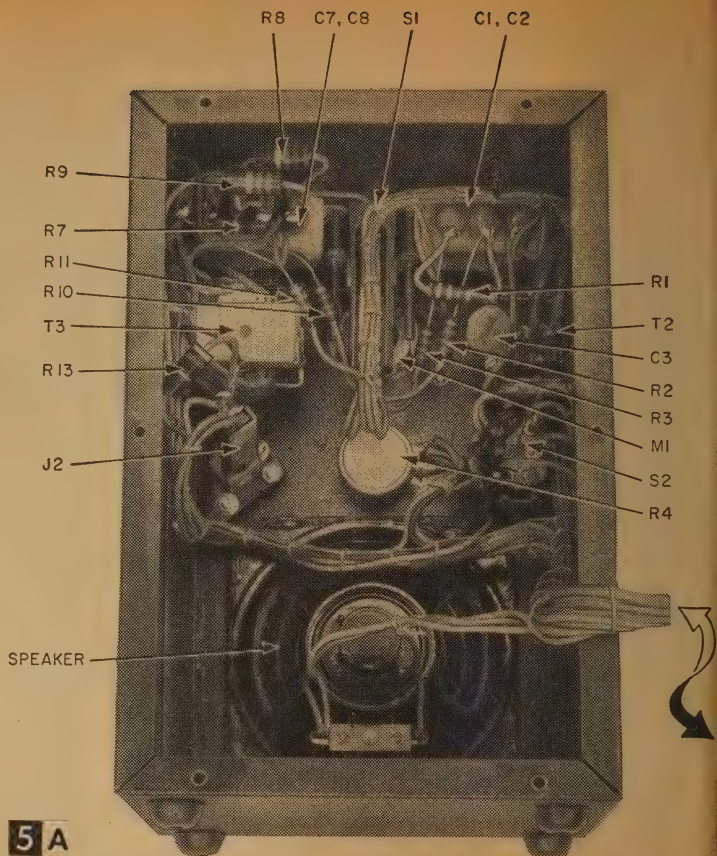
WIRING DIAGRAM
SCUBA DIVER'S EQUIPMENT

is about 350 ma.

The 2N155 output circuit is unusual: in effect, it is a common emitter-type amplifier, with two feedback windings on T3 canceling each other to allow the 2N155 collector to be connected directly to chassis in order to provide an effective heat sink.

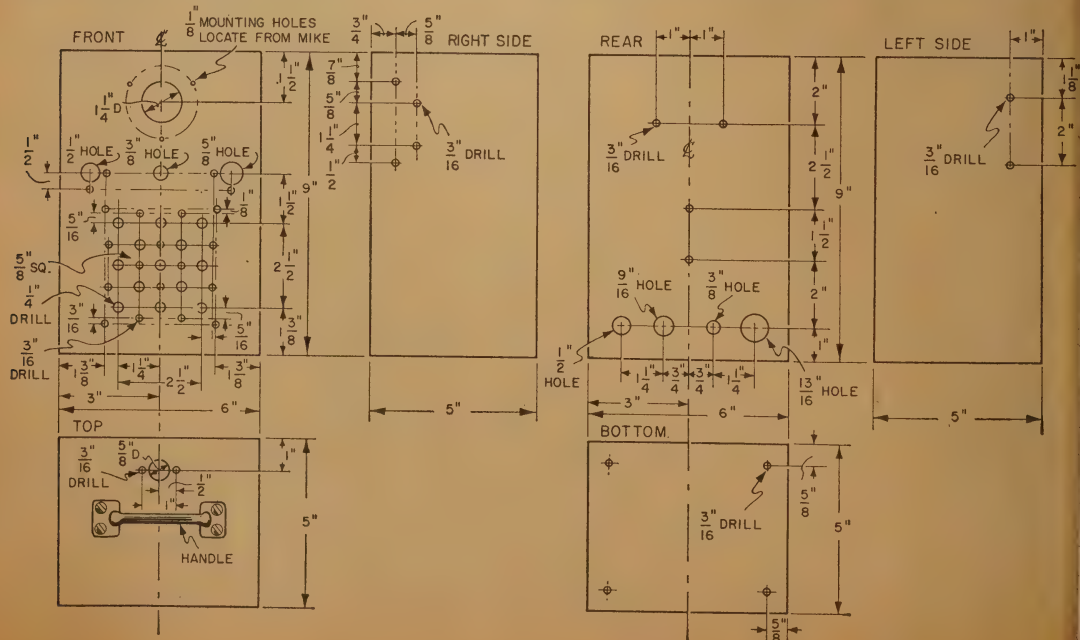
The T3 secondary is connected to the push-to-talk switch, and in normal position, through this switch to the loud-speaker mounted in the case. When the push-to-talk switch is pressed, the output of the amplifier output connects through the remote volume control, R12, to the diver's ear-phone. Capacitor C8 supplies a sidetone circuit which allows the diver to hear himself talk. When he can't hear himself, it warns him that there is no communication to the surface. If you want more sidetone, increase the size of this capacitor.

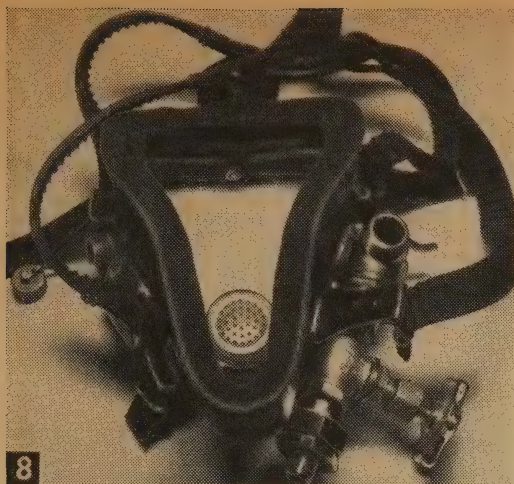
Water Proofing Mike and Phone. The amplifier serves either the scuba or skin diver, or the hard-hat suit diving rig. Since the scuba diver must submerge with a tightly-fitting mouthpiece, speech in the ordinary manner would be impossible; hence a surplus throat



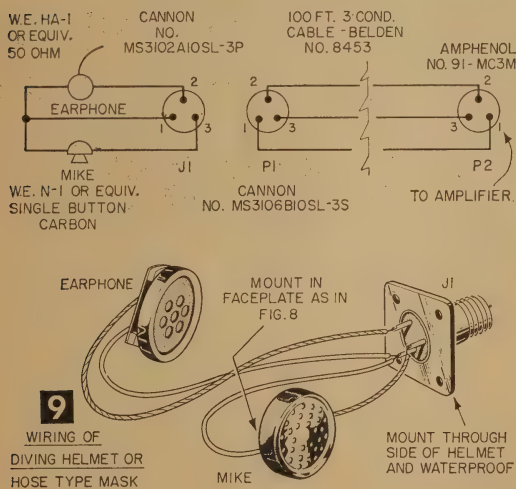
5A

Wiring inside the case is not crowded. Be sure to separate the input from the output circuit wiring to prevent audio howl. The speaker must be coated heavily with waterproofing spray.





8 This type of face mask connects to an air hose. Since the diver has no mouthpiece, the microphone can be installed near the bottom of the plastic faceplate.



stallation of a single button type microphone in the faceplate of the hard-hat diving rig. Waterproof the microphone, and install the earphone, also waterproofed, in the head covering of the suit. Both mike and phones are connected to the 3-wire cable with a surplus AN waterproof connector. Tape the cable directly to the air hose.

Connect the cable to the skin diver's mike and earphone directly—taping and covering the wire joint with Scotchkote. For extensive Scuba diving and exploration, a wire reel and about 150-feet of the 3-wire cable can be arranged for easy operation. Lines to several divers can be connected to the amplifier, simply by wiring in parallel.

If the Scuba diver needs complete freedom of movement, he can shed his phone, mike and cable, and tie it to an underwater marker

MATERIALS LIST—UNDERWATER TELEPHONE

- | No. Req'd | Size and Description |
|------------------|---|
| AMPLIFIER | |
| 1 | R1—4.7K, 1 watt, 10% carbon resistor |
| 4 | R2, R3, R10, R11—220 ohm, 1 watt, 10% carbon resistors |
| 1 | R4—5K, 2 watt, variable resistor (volume control) Ohmite type AB |
| 1 | R5—1K, 1/2 watt, 10% carbon resistor |
| 1 | R6—56K, 0 watt, 10% carbon resistor |
| 1 | R7—22 ohm, 2 watt, 10% carbon resistor |
| 1 | R8—120 ohm, 2 watt, 10% carbon resistor |
| 1 | R9—270 ohm, 2 watt, 10% carbon resistor |
| 1 | R12—60 ohm, 4 watt, variable resistor (remote volume control) IRC type 60 |
| 1 | R13—47 ohm, 2 watt, 10% carbon resistor |
| 1 | R14—4.7K, 1 watt, 10% carbon resistor |
| 5 | C1, C2, C5, C7, C8—0.1 mfd., 200-volt paper capacitors |
| 1 | C3—0.02 mfd., 200-volt paper capacitor |
| 1 | C4—8 mfd., 50-volt electrolytic capacitor |
| 1 | C6—100 mfd., 6-volt capacitor |
| 1 | S1—Televet type 16006L, push-to-talk switch (Alternate Switchcraft 11006) |
| 1 | S2—Arrow-Hart and Hegeman bat handle toggle, type 82024-D |
| 1 | T1—transformer, Argonne AR-123 |
| 1 | T2—transformer, Argonne AR-105 |
| 1 | T3 transformer, Motorola type 25C536761 only (auto radio replacement) available Motorola parts distributors |
| 1 | TR1—Sylvania type 2N35 transistor, NPN |
| 1 | TR2—CBS type 2N155 transistor, PNP |
| 1 | M1—carbon microphone, Western Electric type F-1 or equiv.* (Surplus item available Columbia Electronics; 2251 W. Washington Blvd., Los Angeles, Calif.) |
| 1 | speaker, 4 in. PM type, cone speaker |
| HARDWARE | |
| 1 | J1—connector, 3 conductor, Amphenol type 91-PC3F |
| 1 | J2—telephone jack, Mallory type XP4B |
| 1 | J3—connector, 2 conductor, Amphenol type 80-PC2F |
| 1 | 9 x 6 x 5" steel carrying case, Bud #CC-1095, black wrinkle finish, with handle |
| 1 | 4 x 2 x 2 3/4" box chassis, LMB Model 102 |
| 1 | fuse retainer, Buss type 342001 |
| 1 | shaft lock for R12, Mallory type 12A1496 |
| 1 | socket, transistor |
| 1 | battery holder, Keystone type |
| Misc. | plastic spray, rubber feet, mounting screws, nuts, lockwashers, decals |

Unless indicated otherwise, all parts are available from Lafayette Electronics, 165-58 Liberty Ave., Jamaica 33, N.Y.

PARTS FOR SCUBA OR SKIN DIVER

- | | |
|--------|---|
| 1 | microphone, throat type, Army or Air Force surplus, available from Roscoe Ward Bargain Bazaar, 3831 Hixson Pike, Chattanooga 5, Tenn. |
| 1 | headphone, 11 ohm, low impedance type, Western Electric HA1 or equal |
| 1 | P1—Cannon MS3106B12S-3P, with Cannon MS3057-4A cable clamp (optional) |
| 1 | P2—Cannon MS3106B10SL-3S, with MS3057-4A cable clamp (optional) |
| 1 | P3—Amphenol 91-MC3M |
| 100 ft | 3-conductor cable, rubber covered Belden 8453 with spool, or windup reel |

PARTS FOR SUIT DIVER'S FACE MASK

- | | |
|--------|--|
| 1 | microphone—Western Electric type N1, single button carbon, 50 ohm* |
| 1 | headphone, Western Electric type HA1, or equal |
| 1 | J1—Amphenol MS3102A10SL-3P |
| 1 | P1—Amphenol MS3106B10SL-3S, with Cannon MS3057-4A cable clamp |
| 1 | P2—Amphenol 91-MC3M |
| 100 ft | 3-conductor cable, rubber-covered Belden 8453 |

* Telephone parts are also available from Telephone Repair and Supply Company, 1760 Lunt Avenue, Chicago 26, Ill.

anchored in position. Brightly colored, it will be easy to find for use at any time.

Such a completed underwater intercom will add an immense safety factor for novice divers.

Transistor Analyzer



It's fun to build gadgets, but the serious experimenter soon realizes that this is but a preliminary to real electronic understanding. To master any branch of science, one must learn to take, graph, and analyze *quantitative* data. With this convenient transistor characteristics analyzer you do just that.

By C. F. ROCKEY

BLOCK diagram (Fig. 2) and schematic (Fig. 3) show how this transistor analyzer works. A relatively low-voltage *dc* source provides a "signal" which may be applied in either polarity to either the base or emitter circuit of the transistor under test. Likewise, a variable supply *dc* source may be connected at will to any electrode. Appropriate current-measuring instruments are associated with each source, and either positive or negative terminals of either source may be made the common point by grounding switches. All significant points of the circuit are brought out to terminal screws for convenient reading of all important circuit potentials. Thus voltage/current relationships in any parts of a three-terminal semiconductor element may be conveniently adjusted and measured. Two-terminal crystal diodes may also be studied by connecting to the two appropriate terminals.

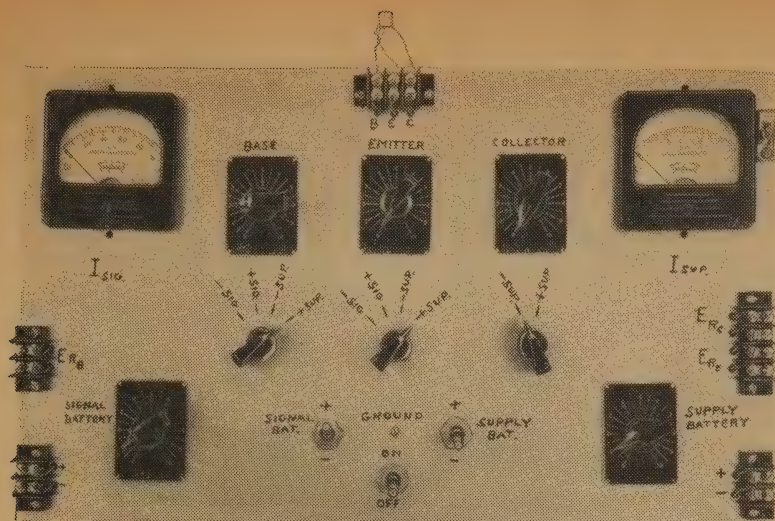
You can build this device easily in a couple of evenings. Total cost to build will be approximately \$50 (including batteries and at least one experimenter's transistor for dem-

onstration). You will also need a volt-ohm-milliammeter of the ordinary radio-servicing sort.

Constructing the Unit. Begin by drilling the major chassis holes (see Fig. 4). Any linear-taper, radio-replacement potentiometers of the right value may be used. They need not be equipped with switches. Multi-element function switches were used, even though so few positions were utilized, because these switches cost no more than those with fewer positions, and the manufacturer provides an adjustable stop so that the user may readily select as many positions as he needs; also, the additional switch positions provide for expansion as the transistor art advances. You may use appropriate switches you have on hand, but make sure that they are of the *non-shorting* type.

After drilling the major holes, drill chassis and mount the Cinch-Jones terminal strips using 6-32 steel machine screws and nuts. Then fasten into place each of the potentiometers and switches.

Solder each connection carefully with rosin-core solder, avoiding short-circuits between lugs or to the chassis. The exact order of the wiring is not critical; just be sure you



1 This analyzer provides maximum flexibility for quantitatively studying the dc and low-frequency interelectrode relationships of transistors.

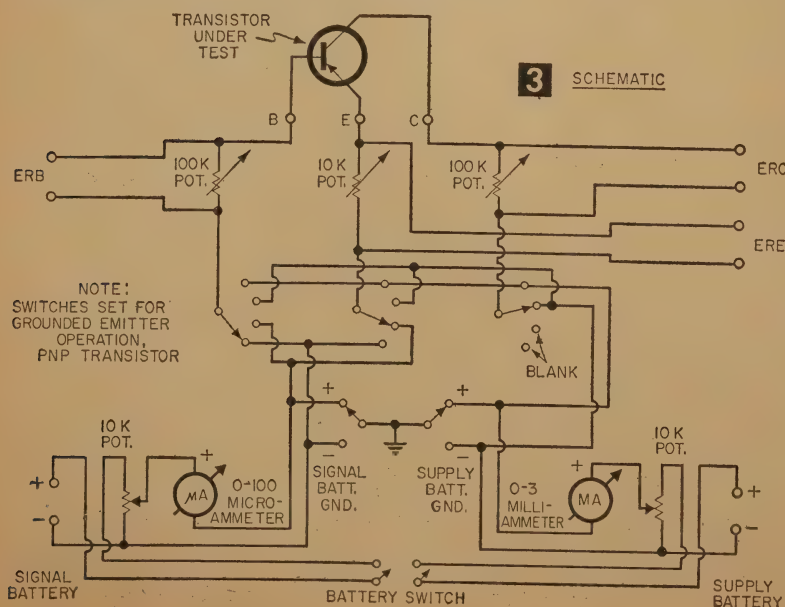
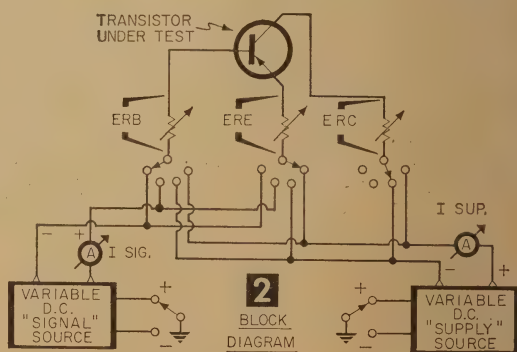
follow an orderly procedure, and check each step carefully.

Finally, install and connect the meters. Be sure to observe the little plus-sign, and polarize these correctly. When the meters have been installed, and the wiring checked, clean off the top of the chassis with carbon tetrachloride, or other grease solvent and mark the terminals and switch positions with a steel pen, using draftsman's ink. When the markings are complete and dry, give the chassis a coat of clear, water-white spray lacquer.

Using the Transistor Analyzer. Prepare the instrument for use by connecting a single 1.5-v flashlight battery to Signal Battery terminals, a 4.5- to 6-v battery to Supply Bat-

tery connections. Be sure to observe correct polarity. I recommend a 6-v "lantern battery," available at most large hardware stores, for the supply battery. Provide connections to it by soldering wires to the spring terminals usually used. Make sure the battery switch is in off position.

Next, connect the leads of the transistor you wish to examine to the terminals provided. Be sure to first ascertain whether it is a PNP or an NPN unit; incorrect information here will cause confusion in the measurements, and may re-



sult in transistor or meter damage.

Perhaps the most significant first determination that can be made is that of the grounded-emitter current transfer characteristic. This property clearly illustrates the control impedance property of the transistor, and thus its ability to amplify. In this measurement we hold the emitter-collector voltage constant, and vary the base current. The corresponding variations in collector current are then observed and tabulated.

Before turning-on the battery switch, set

MATERIALS LIST—TRANSISTOR ANALYZER

No. Req'd	Size and Description
1	aluminum chassis 4 x 10 x 17"
1	0 to 100 microammeter, Triplett Model 327
1	0 to 3 milliammeter, Triplett Model 327
1	DPST toggle switch
2	SPDT toggle switches
3	10K, wire-wound linear taper potentiometers, Mallory
2	100K, linear taper potentiometers, Mallory
3	non-shorting single deck rotary switches, Mallory, Number 1311-L
1	3 terminal, Cinch-Jones terminal strip
1	4 terminal, Cinch-Jones terminal strip
3	2 terminal, Cinch-Jones terminal strip
5	270° dial plates, Croname
8	bar knobs
1	Fahnestock clip
	6-32 machine screws, 1/2" long, steel hex nuts, steel for above, plastic insulated hookup wire, rosin core solder
Also needed for measurements, if not already on hand:	
1	1.5 v flashlight cell
1	6 v lantern battery
1	volt-ohm-milliammeter, or vacuum-tube volt-ohmmeter
1	experimenter's junction transistor

VTVM from the collector to ground. Connection to the collector may be reached directly at the upper terminal of the pair marked Eac, and ground connection may be made to the Fahnestock clip.

Turn on the battery switch and adjust the supply battery potentiometer to 1.5 v from collector to ground. This may cause the Isig microammeter to read backwards. If it does, slowly advance the Signal battery potentiometer until it reads at zero. (This "back current" is due to normal interaction within the transistor.) After this change has been made you will probably have to reset the Supply battery pot to the correct voltage. (The input and output circuits of a transistor are interrelated, unlike those of a vacuum-tube at low frequencies which are isolated.)

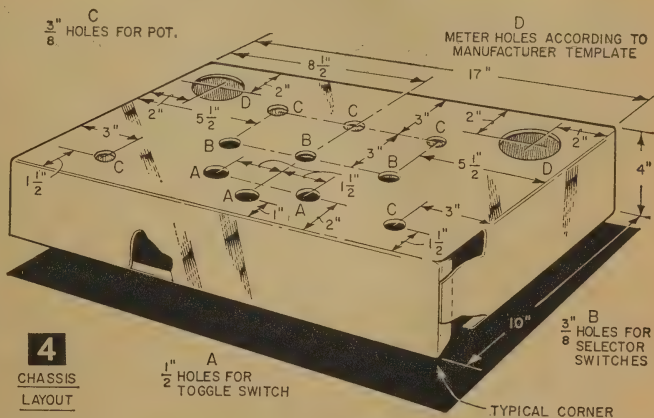
With the collector voltage at 1.5 v and the base current (Isig) at zero, observe and tab-

up the other controls as follows: For an NPN transistor (grounded emitter connection): Base selector switch, +sig; Emitter selector switch, -sup; Collector selector switch, +sup; Signal battery grounding switch, -ground; supply bat grounding switch, -ground.

For a PNP transistor: Base selector switch, -sig; Emitter selector switch, +sup; Collector selector switch, -sup; Sig bat grounding switch, +ground; Sup bat grounding switch, +ground.

In either case, the potentiometers in series with each element of the transistor should be set to zero resistance position. Set both of the battery potentiometers to zero voltage position.

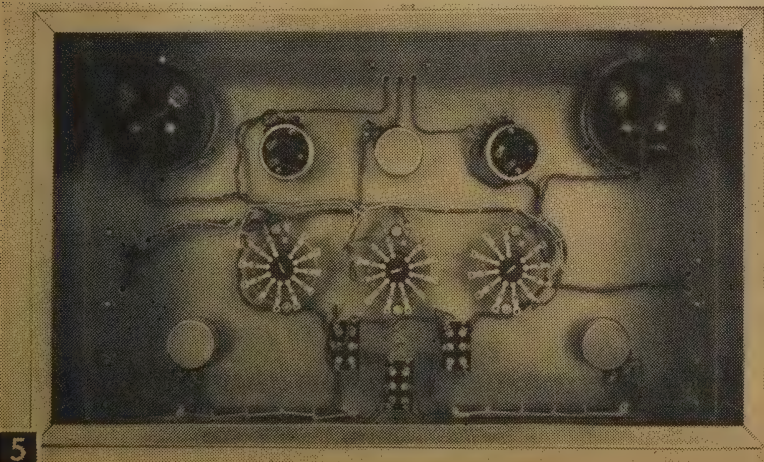
Now, using the 10-v (or similarly-scaled) range, connect a radio-serviceman's VOM or



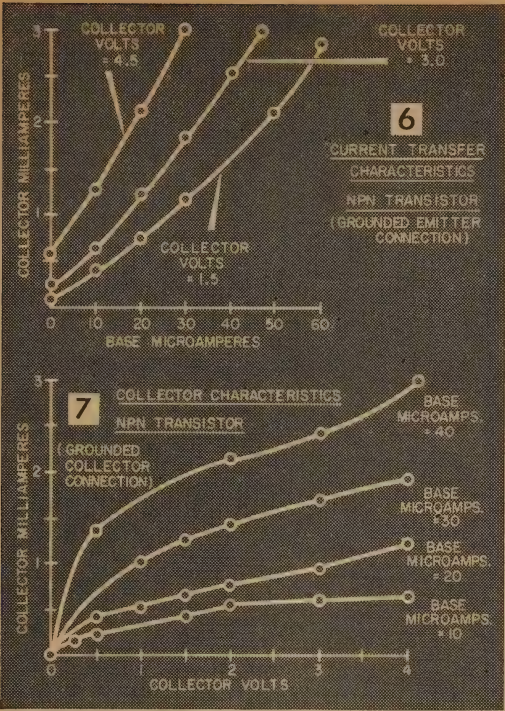
ulate the collector current, which will be read from Isup, the 0-3 milliammeter. Now, keeping the collector voltage at 1.5 v. by adjustment of the Supply battery potentiometer, advance the Signal battery potentiometer to make the base current 5 microamperes. Jockey the two battery pots as necessary to achieve this condition. Again, observe and tabulate the collector current, Isup. Repeat, in 5 - microampere (base current) steps until the maximum collector current of 3 milliamperes is reached.

Be sure that the voltage from collector to ground remains at 1.5 v at the time each reading is taken.

When all of this data has been taken, plot it



Under-chassis view of completed analyzer.



in graphic form. It is customary to plot the independent variable, in this instance the base current, along the horizontal axis (abscissa) and the dependent variable, the collector current, along the vertical (ordinate) axis.

Figure 6 represents a set of curves taken in this manner using a popular brand of experimenter's NPN junction transistor. When completed, such a graph may give rise to a number of significant conclusions. One of these might be that since with an E_c of 4.5 v an approximate base current change of 12 microamperes gives rise to a collector current change of one milliampere, or 1000 microamperes, this transistor provides a current amplification of about 80 times. Is there any doubt as to why such a transistor is useful in practical electronics?

Another useful transistor relationship is that between the collector current and the collector voltage, when the base current is kept constant (grounded collector connection). A family of such curves run by the author (using the same NPN unit) is shown in Fig. 7. The identical switch setup, as used for the transfer curves is used for this investigation. Such a family of curves is of first importance to an engineer, who must match a given transistor to a given load resistance, in a practical design problem.

With increasing experience in the use of this analyzer, a student may plan and execute many interesting measurements and experiments. Curves resulting from several such

TABLE A—SWITCH SETTINGS FOR TRANSISTOR CIRCUIT CONFIGURATIONS:

COMMON EMITTER:	NPN	PNP
Base Selector Switch	+sig	-sig
Emitter Selector Switch	-sup	+sup
Collector Selector Switch	+sup	-sup
Signal Battery Grounding	-ground	+ground
Supply Battery Grounding	-ground	+ground

Isig reads base current, Isup reads collector current. Load resistance provided by Collector series potentiometer.

COMMON BASE:	NPN	PNP
Base Selector Switch	+sig	-sig
Emitter Selector Switch	-sig	+sig
Collector Selector Switch	+sup	-sup
Signal Battery Grounding	-ground	+ground
Supply Battery Grounding	-ground	+ground

Isig reads emitter current, Isup reads collector current. Load resistance provided by Collector series potentiometer.

COMMON COLLECTOR:
Same as for common emitter, except that the load resistance is provided by the potentiometer in series with the *Emitter*.

investigations, as made by the writer, are shown in Figs. 8, 9, and 10. All of the usual transistor circuit configurations can be investigated by merely selecting the appropriate switch settings (see Table A).

Due to the non-uniformity of experimenter's-type transistors, you should not expect your measurements to agree with the author's. Corresponding curves should be of approximately the same shape, however.

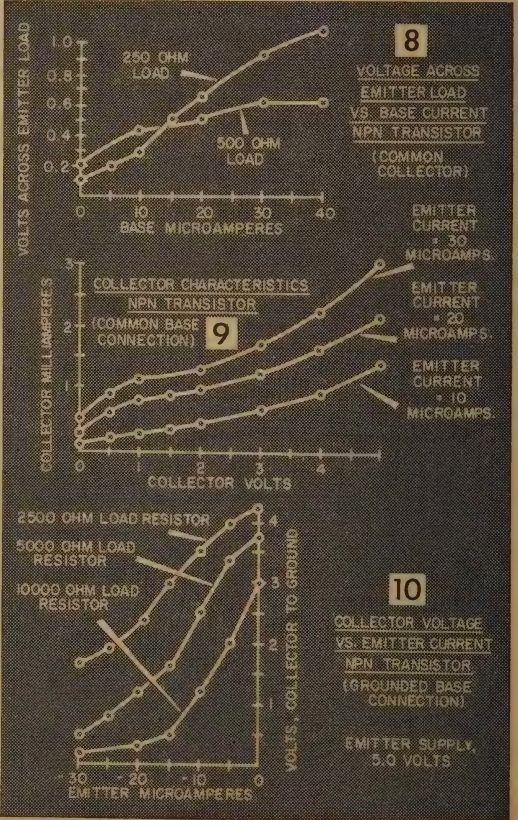
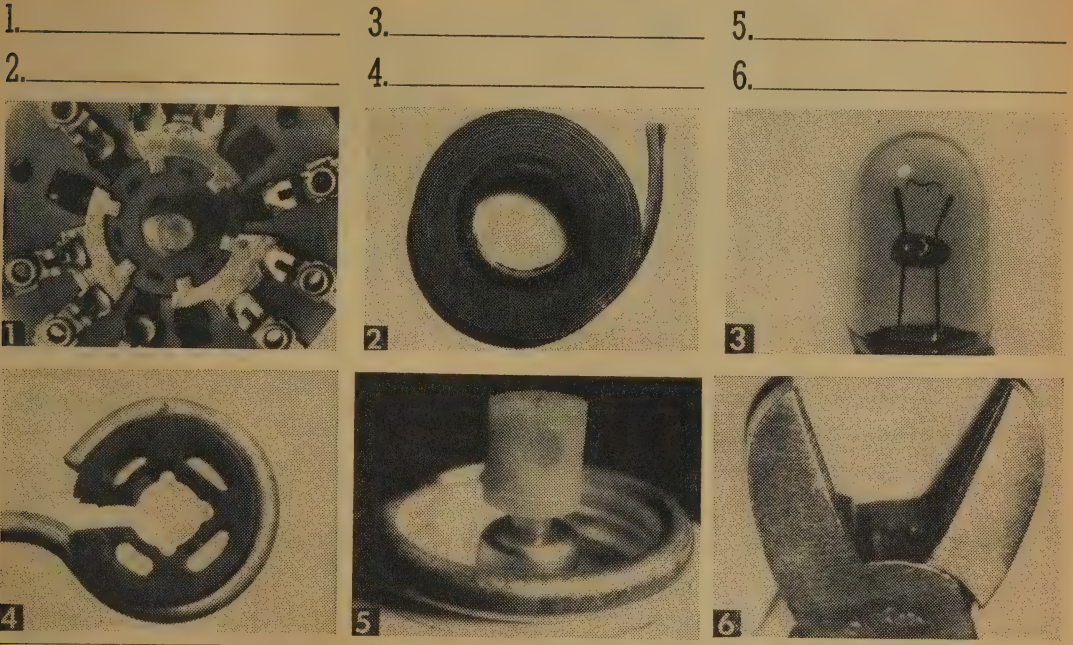


Photo Quiz

Turn a camera loose in a radio-electronic hobbyist's shop and it will come up with some odd-looking pictures. Do you have a good "eye" for solving photo quizzes? Write in the names of the objects in the spaces provided, then check your answers against those on page 122.



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1

Panel view of unit, showing parts placement, with voltage control knob in center.

AC Power Panel

Simple unit checks power input and
furnishes various ac voltages

By W. F. GEPHART

Problem: A TV or radio set that goes bad only between 5:30 and 7:00 PM, or on rainy Monday mornings.

Problem: An electric motor that heats up excessively, even though the shaft turns freely.

Problem: Can a small radio output transformer be used as a step-down voltage transformer for a given load?

The solution to all of these problems lies in the metered variable-voltage power unit shown in Fig. 1. By reducing the normal line voltage to the TV set and radio (as happens when electric stoves create a peak load at dinner time, or when electric clothes dryers are being used on rainy Mondays), adjustments can be made to the set to provide proper operation at lower line voltages. By checking the current being drawn by the motor, evidence of shorted windings can be found. And by checking the current into the transformer as the voltage is increased, and comparing with its rating, its suitability for a given job can be determined.

There are many other uses for a high-powered, metered, variable ac power source in servicing work, appliance repair, and gen-

eral experimental work. By using surplus or imported meters, and adapting the common ac voltmeter to the more scarce ac ammeter, costs can be kept down to a reasonable figure. Excluding the cabinet, and by using 2½-in. meters, the unit shown can be built with surplus parts for less than \$20, as compared to nearly \$40 if built with new parts.

Basically, the unit consists of a variable voltage auto-transformer, an ac voltmeter and ac ammeter. Switches transfer the voltmeter connections, cut the ammeter and auto-transformer in and out of the circuit and (in the unit shown) provide two ammeter ranges. Figure 1 and the schematic (Fig. 2) also show a neon pilot light

MATERIALS LIST—POWER PANEL

(Applicable to unit shown in Fig. 1)

Desig.	Description
R1	56,000 ohms, ½ watt (not required if included in PL)
R2	27,000 ohms, ½ watt (see text)
T1	7.5 amp variable auto-transformer (Superior Electric 116U, Standard Electric 500BU or T51U, Ohmite VT-8, or surplus unit of desired ampere capacity)
T2	"Current Transformer" (see text)
S1	DPST toggle (see text)
S2	DPDT toggle (see text)
S3, S4	SPDT toggle, 3 amp
S5	SPST toggle, 3 amp
PL	neon pilot light holder (Dialco 95408X or equivalent)
M1	0-150 volt a-c meter
M2	low-range a-c voltmeter (see text)
S01	female panel receptacle (Amphenol 61-F1)
	6 x 7 x 12" cabinet (Bud CU-1124), binding posts (optional), plastic scraps, miscellaneous hardware

Some companies handling surplus material where auto-transformers and meters might be secured:

Advance Electronics, 6 West Broadway, New York 7, N. Y.
 Barry Electronics Corp., 512 Broadway, New York 12, N. Y.
 Columbia Electronics, 2251 W. Washington Blvd., Los Angeles 18, Calif.
 G & G Radio Supply, 51 Vesey Street, New York 7, N. Y.
 Hi-Mu Electronics, 133 Hamilton St., New Haven, Conn.
 Peak Electronics, 66 W. Broadway, New York 7, N. Y.
 Standard Surplus, 1230 Market Street, San Francisco 3, Calif.
 TAB, 111-WD Liberty Street, New York 6, N. Y.

Also refer to local Classified Telephone Directories under the headings of:

"Radio Equipment and Supplies"
 "Electronic Equipment and Supplies"
 "Surplus Materials"

and binding posts paralleling the outlet socket, neither of which is absolutely essential.

The only unusual item is the home-made "current transformer" (T2), the details of which are shown in Figs. 3 and 4. AC ammeters are scarce in surplus stocks, and since any ammeter's scale is non-linear, lower values are hard to read. Both of these problems are overcome by using a simple low voltage ac meter, the "current transformer," and multipliers to provide two or more ranges.

The transformer shown was made by wrapping insulated #14 wire around an old relay coil. The coil used was from a surplus relay, has a *dc* resistance of nearly 7000 ohms, and is about 2 in. long and of 1 in. dia. The #14 wire (top winding of T2 in Fig. 2) is in series with the power line through the unit, and current flowing through these turns of heavy wire induce a voltage in the relay coil, which deflects meter M2. The action is fairly linear, and the meter can readily be calibrated in amperes.

The meter used was a 0-2 volt ac meter. About 8 turns of #14 wire give a full-scale deflection (2 volts) when 3 amperes flow through the circuit. Smaller wire, with more turns, could be used to get greater deflection. For example, 3 amps flowing through the additional turns permitted by using #18 wire might give induced voltages of over 5 volts, permitting the use of a higher range voltmeter.

To make the transformer, first decide on the current to be required to give a full-scale deflection of the meter on the lowest range (if more than one range is desired). Then make a mounting for the relay coil on the back of the meter, as shown in Figs. 3 and 4. Temporarily connect the relay coil terminals to the voltmeter and solder one end of the heavy wire to the lug at one corner of the mounting plate. Wrap as many turns of heavy wire as

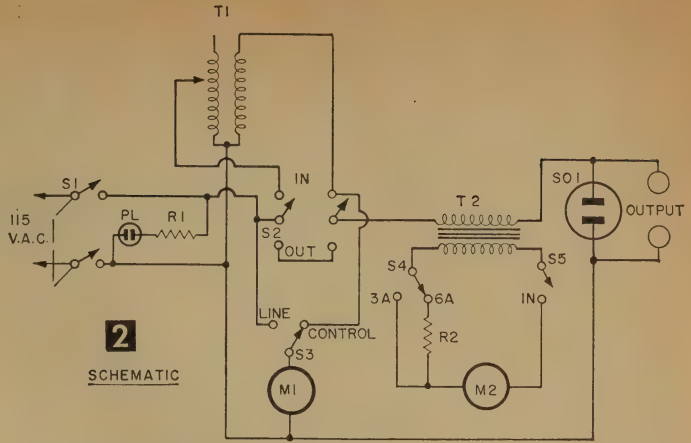


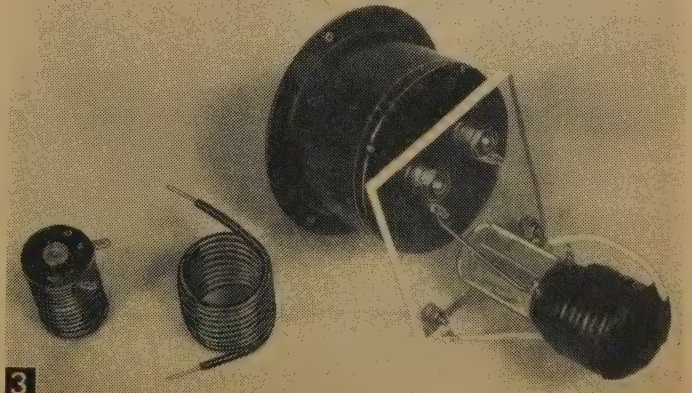
TABLE A—LIGHT BULBS REQUIRED TO GIVE SPECIFIC CURRENTS (at 120 volts)
Note: The wattage rating of domestic lamps is usually quite accurate. Due to the combinations used for most readings, any inaccuracies tend to offset each other. However, only new or relatively new lamps should be used for the greatest accuracy.

FOR CURRENT (amperes)	WATTS REQUIRED	LAMPS REQUIRED (connected in parallel)
.125	15	15
.25	30	15 + 15
.5	60	60
.75	90	60 + 15 + 15
1.0	120	100 + 10 + 10
1.25	150	150
1.5	180	150 + 15 + 15
1.75	210	150 + 60
2.0	240	200 + 15 + 15 + 10
2.25	270	200 + 60 + 10
2.5	300	200 + 100
2.75	330	200 + 100 + 15 + 15
3.0	360	200 + 100 + 60
3.25	390	200 + 150 + 25 + 15
3.5	420	200 + 150 + 60 + 10
3.75	450	200 + 150 + 100
4.0	480	300 + 150 + 15 + 15
4.25	510	300 + 150 + 60
4.5	540	300 + 200 + 25 + 15
4.75	570	300 + 200 + 60 + 10
5.0	600	300 + 200 + 100
5.25	630	300 + 200 + 100 + 25 (minus 5W)
5.5	660	300 + 200 + 100 + 60
5.75	690	300 + 200 + 150 + 40
6.0	720	300 + 200 + 150 + 60 (minus 10W)

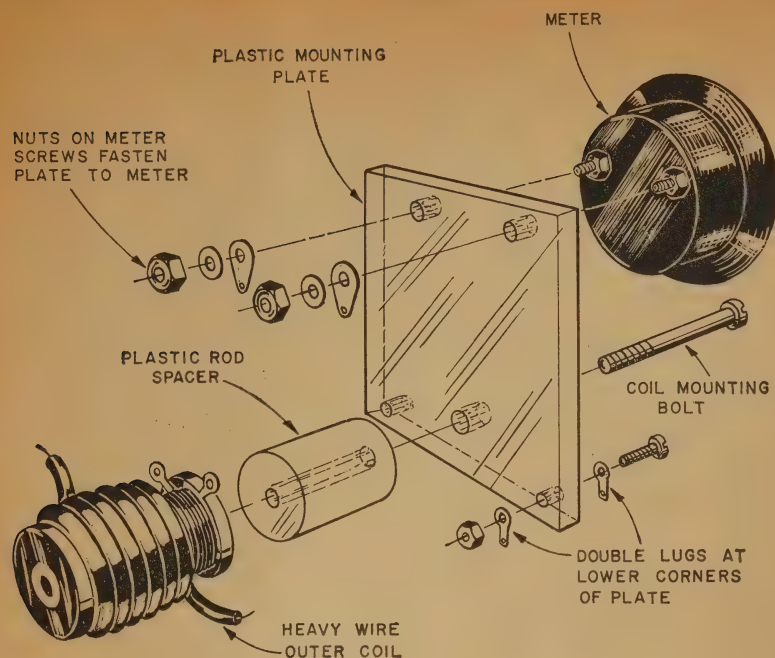
Lamps required to calibrate to 3 amperes: two 10 watt, two 15 watt, one 60 watt, one 100 watt, one 150 watt, one 200 watt

Additional lamps required to calibrate to 6 amperes: one 25 watt, one 40 watt, one 300 watt.

Four sockets will be maximum required for either calibration.



"Current transformer" and meter, showing at left the type of relay coil and heavy wire used.



4 CURRENT TRANSFORMER MOUNTING

possible around the relay coil (single layer) and hold the turns in place with a turn or two of plastic electrician's tape. Connect the coil of heavy wire in series with the load desired for full-scale reading (see Table A).

If the meter goes off-scale, reduce the number of turns of heavy wire by unwinding the free end of the coil, a turn at a time. Continue checking the meter reading, and as the exact full-scale point is approached, reduce the turns by half- and quarter-turns, to get the exact winding required to give full-scale deflection when the desired current is flowing. When this point is reached, tape the free end of heavy wire on the relay coil, and solder the end to the lug at the other corner.

If the full number of turns will not give full scale deflection for the desired current, these are several alternatives. One, use a meter of greater sensitivity; two, try winding a second layer of heavy wire; three, increase the current desired for full-scale deflection; and four, use smaller wire. The second layer of wire may reduce induced voltage unless wound carefully, and the use of smaller wire may be undesirable if it has insufficient current capacity for the full load required, particularly if several ranges are to be used.

In making the transformer mounting, make the plastic rod spacer as long as possible (within the limits of the cabinet chosen) to keep the relay coil away from the meter. This is particularly important if the meter is in a non-metallic case, as it reduces the possibility

of the magnetic field around the coil affecting the meter action.

To determine the multiplier used for the higher range (R2), use a variable resistance or resistance decade. Set the value high (50K or more), and connect the load required to give the desired deflection at full-scale on the higher range. The meter should read less than full-scale, and gradually reducing the resistance to the value required for full-scale deflection will give the multiplier (R2) value required.

To calibrate the meter, place the meter-transformer assembly in the panel (if a metal panel is used), and, using the lamp combinations shown in Table

A, note the meter readings on the existing scale at different current values, for both ranges (if more than one is used). In the unit shown, intermediate markings were not made up to 3 amps on the 6-amp scale, since those values would be read on the lower range.

There are definite reasons for the voltmeter switch (S3), the voltage control switch (S2), and the ammeter switch (S5). The voltmeter switch permits the voltmeter to be switched to read either direct line voltage or controlled voltage. The voltage control switch allows the control to be switched out of the circuit to permit measurement of current at direct line voltage, without "artificial" adjustment. The ammeter switch permits the ammeter to be switched out of the circuit when using devices that have a high starting current in excess of meter capacity, but a lower running current.

No dimensions are given, as they will vary with individual needs and the exact surplus parts secured. For most use, a 3-amp auto-transformer will do, as it will handle up to 360 watts, although a larger unit might be needed if much work is done with fractional horsepower motors.

Two-in. meters will do, although three-in. meter faces give longer scale length and only cost a dollar more at most surplus houses. Switches S1 and S2 must have a current capacity equal to the maximum to be handled by the unit; the others can be standard 3-amp switches.

One-Tube Tin Can Receiver

Here is an inexpensive one-tube broadcast band receiver that will give four-tube performance. Stations nearly 70 miles away come in with good loudspeaker volume

By JOE A. ROLF, K5JOK

A one-lb. tobacco can contains the receiver and its 4" PM speaker. Tuning and volume controls are on top of the lid, speaker is mounted in the bottom of the can. Power cord and antenna lead also enter the cabinet from the bottom.



If you're a pipe smoker, you no doubt already have a cabinet for this receiver. If not, you probably have a friend who buys his tobacco in a one-lb. can. An empty cigar tin or a two-lb. coffee tin can also be used or, if desired, the unit can be easily built on a small standard chassis.

A Prince Albert tobacco can, 5 in. high and 5 in. dia., was used as cabinet by the author. Some tobaccos are packaged in slightly smaller containers and using one of these may make it necessary to alter the parts layout slightly from that shown in Figs. 3 and 4. However, with care there will be no difficulty in getting the components to fit easily in any one-lb. tin you use.

If you're an old-timer in radio, you'll probably recognize the circuit shown in Fig. 2. Similar to those popular in the days when multi-tubers were large and cumbersome and vacuum tubes expensive, it's a reflex circuit designed for economy and compactness and making a single tube do the work of two—both RF and AF amplifier. Here's how the reflex circuit shown in Fig. 2 works:

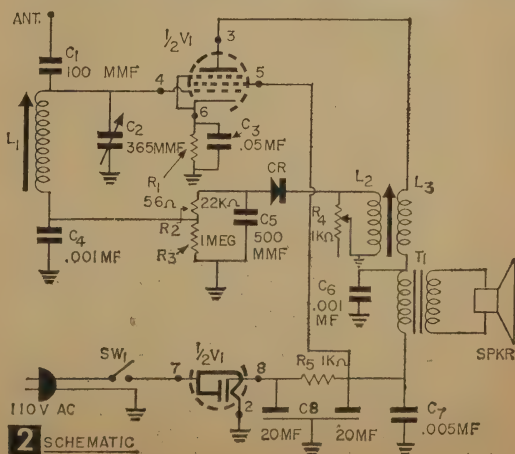
The 117N7/GT contains a rectifier and power pentode section in the same envelope. The rectifier is employed as a half-wave power

supply, the pentode works as a combination RF-AF amplifier. A crystal diode (CR) is used for an RF detector.

Radio signals enter the receiver from the antenna through C1 and the desired station is selected by the tuned circuit formed by C2 and L1. The selected signal is then amplified by the tube which is biased for RF amplification by the cathode resistor R1. The amplified signal appears across L2 in the plate lead of the tube and, since L2 and L3 form an RF transformer, RF is transferred to L3; RF does not flow through the primary of the output transformer T1, but is passed to ground by C6 which offers very little impedance to RF.

The amplitude of the signal appearing across L2 is controlled by R4 (the volume control). This voltage is rectified by diode CR, and an AF voltage appears across the detector load, R2 and R3. Any RF still present at this point is passed to ground by C4 and C5 which have low impedance to radio frequencies, but high to audio frequencies.

The grid of the tube is connected between



R2 and R3 where the AF voltage is negative with respect to ground. This negative audio voltage, acting through L1 (low AF impedance) biases the tube automatically and causes it to act as an AF amplifier. The AF signal in the tube's plate lead is not affected by L3, nor is it transferred to L2. Nor is it grounded by C6. Instead, it appears across the primary of the audio transformer T1 to operate the speaker connected to the secondary winding.

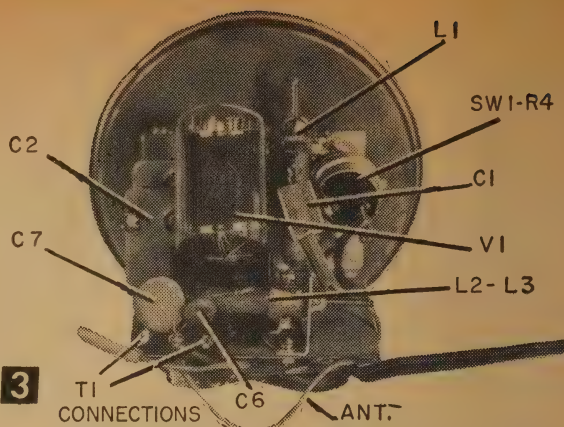
Construction. The receiver is built with the speaker and output transformer mounted in the bottom of the can and other components mounted on an L-shaped chassis which is fastened to the lid of the can by the volume control shaft and two machine screws. The chassis may either be of aluminum or sheet metal. Sheet metal will be somewhat harder to work, but will allow the builder to solder ground connections directly to the chassis without using solder lugs.

Form the chassis from a piece of material $3\frac{1}{4} \times 5$ in. bent to a right angle with sides measuring $2 \times 3\frac{1}{4}$ in. and $3 \times 3\frac{1}{4}$ in. The 2-in. side fastens to the lid with the other leg of the angle centered about $\frac{3}{4}$ in. from one edge of the lid. The $2 \times 3\frac{1}{4}$ -in. covers most of the lid to reinforce the thin material to which it is attached. The 3-in. leg is used for mounting the components.

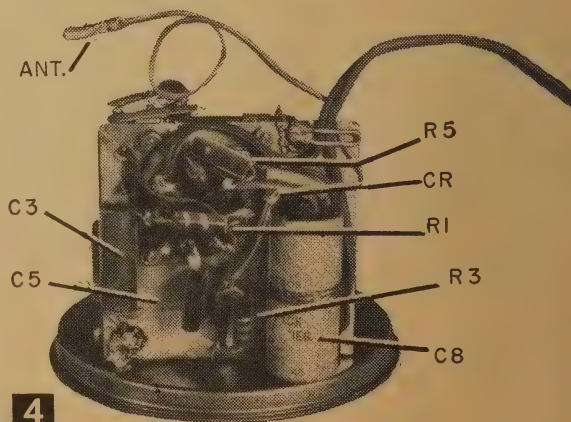
Tuning capacitor, C2 and volume control R4 are placed so that their shafts are centered in the lid. The tube socket is placed behind C2 as close as possible. Transformer L2-L3 is mounted horizontally next to the tube as shown in Fig. 3, while L1 is mounted in a vertical position between the tuning capacitor and volume control. A two-lug terminal strip on the top of the chassis, at the right rear edge, is used to connect the output transformer leads to the chassis. Capacitors C6 and C7 are also mounted on this strip.

Filter capacitor C8 is placed on the right underside of the chassis and next to it, toward the front, is a two-lug terminal strip for mounting R2, R3, and C5. The layout of the remaining components is not critical, but care should be taken that the lid will fit properly with everything mounted and that the grid and plate leads are separated as much as possible to avoid the possibility of feedback. It is particularly important that L1 and L2 be mounted at right angles to one another and separated as much as possible in order to minimize coupling.

The RF transformer L2-L3 is made by winding 75 turns of litz wire (obtainable from a discarded RF or IF coil) over the windings of a ferrite antenna coil. The added



Chassis for the receiver is an L-shaped bracket which fastens to the tobacco can lid. This photo shows the layout of parts on the topside of the chassis. Leads from the output transformer are soldered to the terminal strip at the rear edge.



Underside of chassis. Holes for bringing leads from the top of the chassis should be placed so that plate and grid leads are short and separated from one another.

winding should be secured with several coats of coil dope or finger-nail polish. The original winding is L2; the added winding, L3.

A 12-in. piece of hookup wire brought out of the cabinet with the power cord serves as an antenna lead-in to the chassis. A pin-jack from a discarded tube socket can be soldered to this wire and shielded with tape or plastic tubing to make a handy antenna jack.

Mount the speaker in the bottom of the can with four machine screws. Output transformer T1 can be mounted with screws or soldered in place. If the recommended speaker is not used, its replacement should not extend above the bottom of the can more than $1\frac{3}{4}$ in., otherwise the chassis may have to be made smaller.

Small holes in the bottom of the can serve as a speaker grille. Or, for better tone, cut a 4-in. dia. hole in the bottom with a sharp

MATERIALS LIST—TIN CAN RECEIVER

Desig.	Description
C1	100 mmf. mica capacitor
C2	365 mmf. variable (double-bearing replacement type) capacitor
C3	.05 mf. 200 WV midget tubular capacitor
C4	.001 mf. disc ceramic capacitor
C5	500 mmf. mica capacitor
C6	.001 mf. disc ceramic capacitor
C7	.005 mf. disc ceramic capacitor
C8	20-20 mf. 150 WV dual electrolytic (Cornell Dubilier BBRD 2215) capacitor
Cr	1N34 or CK-705 diode
L1	hi-Q ferrite antenna coil
L2	hi-Q ferrite antenna coil
L3	75 turns of litz wire wound over L2 (see text)
R1	56 ohm, 1/2 watt resistor
R2	22,000 ohm, 1/4 watt resistor
R3	1 megohm, 1/4 watt resistor
R4	1,000 ohm, 1/4 watt volume control (with SPST switch)
R5	1,000 ohm, 1 watt resistor
Spk	4" PM replacement type speaker, 3.2-ohm coil (Jensen 4J6 or Cletron PM-4P2)
Sw1	SPST switch (on volume control R4)
T1	3,000/3.2 ohm, 3-watt output transformer
V1	117N7/GT tube
	1 wafer or saddle-mount octal socket, 2 terminal strips (2-lug type), twenty 1/8 x 1/4" machine screws, 5' power cord with plug, 3/4 x 5" pc. of #16 or #18 ga. aluminum or sheet metal, 12" #8 copper wire, plain or tinned, solder & hook-up wire.

knife. But watch the sharp edges! When the mounting holes for speaker and output transformer have been drilled plus a hole at one edge for the power cord, glue a piece of perforated cardboard over the bottom of the can to protect the speaker cone.

Then make three hairpin legs of #8 silvered copper wire formed into V shapes 1 1/4 in. high and soldered in place. For gold legs, use untinned copper wire that has been polished and given a coat of clear finger-nail polish to retard tarnishing.

With completion of chassis wiring and speaker mounting, bring the power cord and antenna lead through the hole in the bottom of the can and attach a power plug. Next, solder the output transformer primary leads to the lugs of the terminal strip at the rear of the chassis. These leads should be long enough to permit the chassis to be removed from the cabinet with the speaker in place.

To test the unit, use a long antenna. (The set should never be grounded or operated on a metal surface.) With an antenna connected, turn the set on and advance the volume control to maximum. Check and see if the filaments are lit before tuning across the band. If working properly, the receiver will receive stations clearly—or with a whistle. In either case, find a strong station at the high end of the band and adjust L2's slug for best reception. At some point of adjustment the audio will become distorted. Set the slug just below this point.

Because of the metal cabinet and the absence of a loop antenna, a short external antenna is necessary. For local stations, 4 ft. of hook-up wire is sufficient. For distant stations, a longer length strung around the room will do. When the set is working properly,

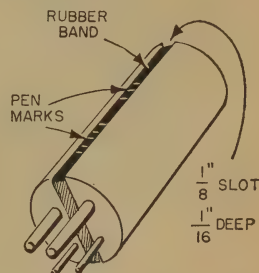
connect a short antenna and adjust L1 so that C2 tunes the entire broadcast band and then adjust the slug on L2 again for best reception. The receiver is now ready to be placed in its cabinet.

A small amount of regeneration requires the initial adjustment of L2 to avoid distortion or oscillation at the upper edge of the band. This also tends to make the receiver more sensitive on the high end of the band, but volume for all stations is nearly the same due to the AVC action of the audio bias. While not as selective, the receiver has better tone than most small table-models, despite the small speaker and tin cabinet. If poor selectivity is noticed when the set is operated near local, high-power stations, reduce the value of C1 by about half.

Note: To avoid the possibility of shock, either: 1) always plug the power cord into the 110-v outlet with the cabinet common to the ground side of the power line (this will also give best reception); or 2) completely isolate the line from the cabinet and chassis by making all ground connections to a terminal lug insulated from the chassis. Capacitor C4, however, should be grounded to the chassis to provide an RF return to the tuning capacitor frame.

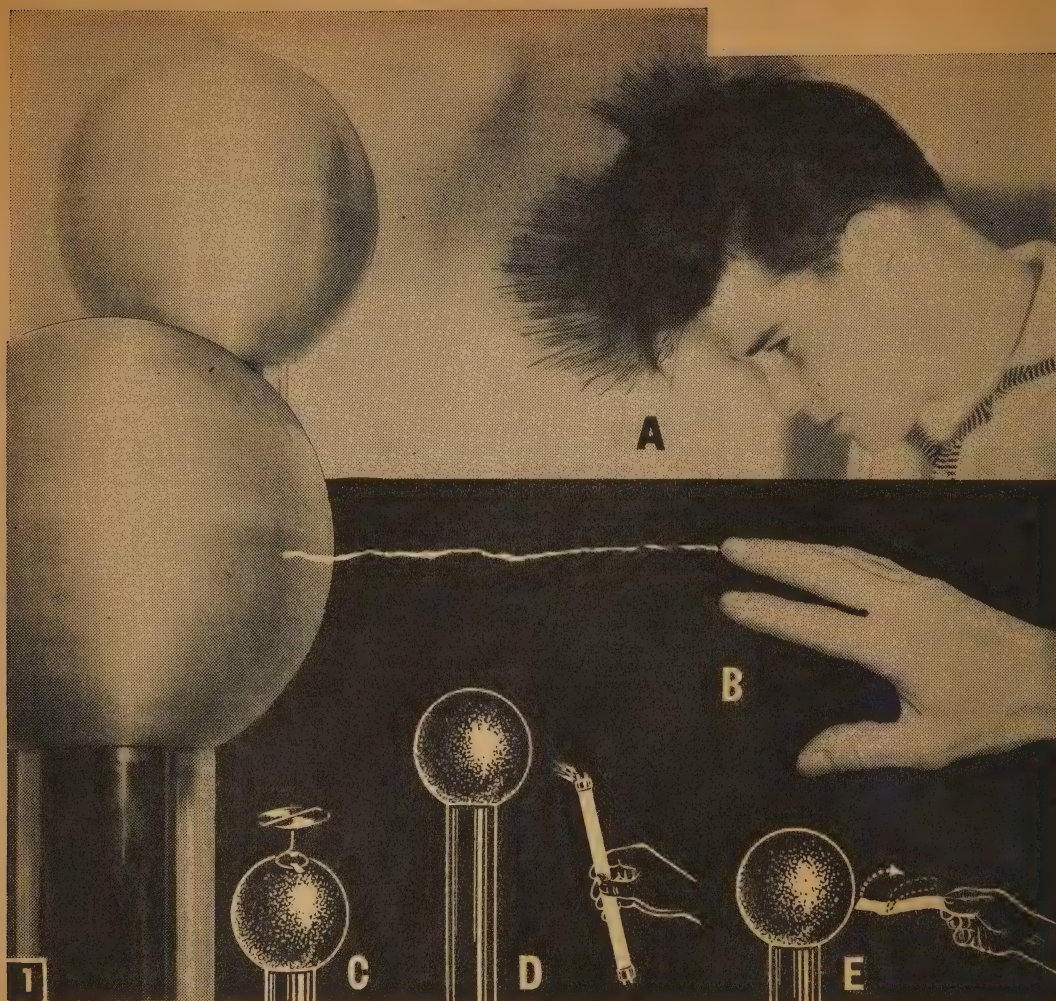
Coil-Winding Tip

• Amateur radio operators who wind their own short wave coils know how difficult it sometimes is to properly space and anchor just a few turns of wire. The solution is to saw or file two opposite slots 1/8 in. wide and about 1/16 in. deep on the top edge of the coil form. Place a wide, flat No. 32 rubber band in these slots and stretch it over the form and between two pairs of prongs. Fountain pen or ball pen marks are easily made on the rubber band, exactly where each turn of wire should pass. Draw the wire tightly to embed it in the insulating rubber and hold it neatly in place without the use of cement.



Invert Aerial to Speed Installation

• The neighbors may think you're crazy if you start the installation of a TV or radio aerial upside down, but doing this will help you to quickly and easily align a bracket on the edge of your house. By having the mast parallel a corner of the building, one of the windows, or some other vertical part, it is easy to sight the alignment while adjusting the mounting bracket. Then you need only reverse the mast to finish the job.



(A) Standing close to the sphere stands your hair on end and charges to tingle your scalp. (B) Blue flashes will jump to your fingers held 12 in. or more away. (C) Corona point discharge from the tips of a wire rotor spins it like a pin wheel. (D) When end of a fluorescent tube is held closely to sphere, small streamers of blue discharges burn from the lamp terminals and lamp lights. (E) Cloth strip shows electrostatic laws of attraction and repulsion. Tossing a strip of cotton cloth at sphere causes it to remain horizontal. When end touches sphere, it becomes charged to its polarity and is violently repelled.

Experimental Van de Graaff Generator

Develop up to 380,000 volts on the same principle as scuffing across a heavy rug

By HAROLD P. STRAND

YOU can build a simplified version of the electrostatic generator developed in 1931 by Dr. Robert J. Van de Graaff that aided in the development of the atomic bomb. The full-size generators produce several million volts on an aluminum sphere at the top of an insulated column.

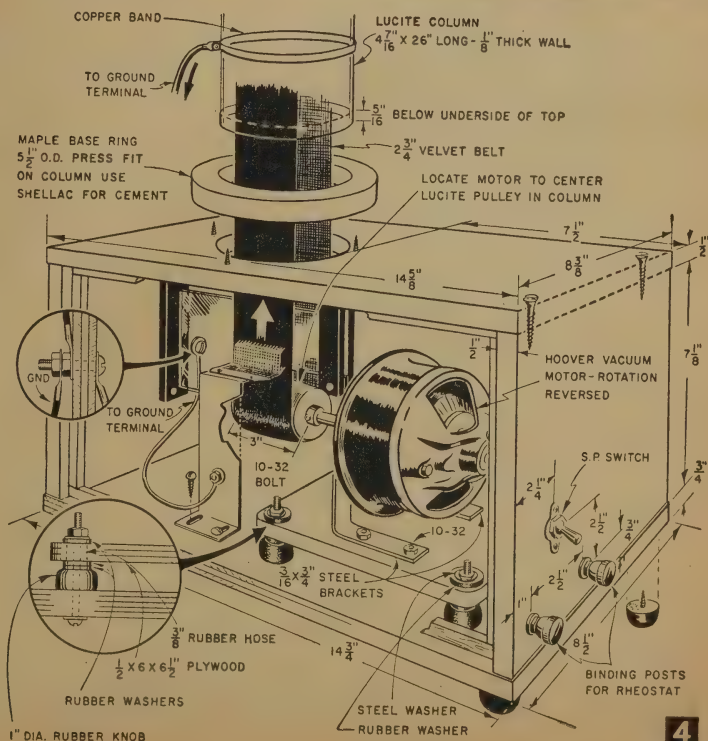
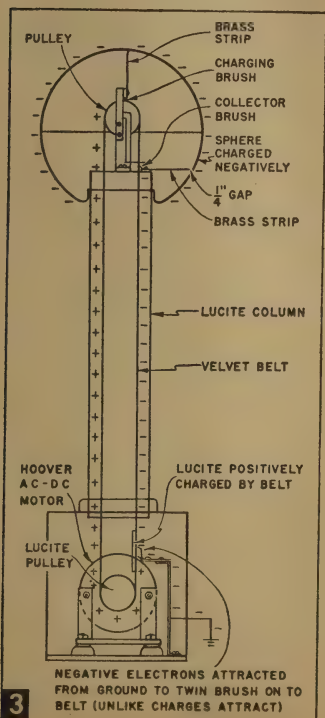
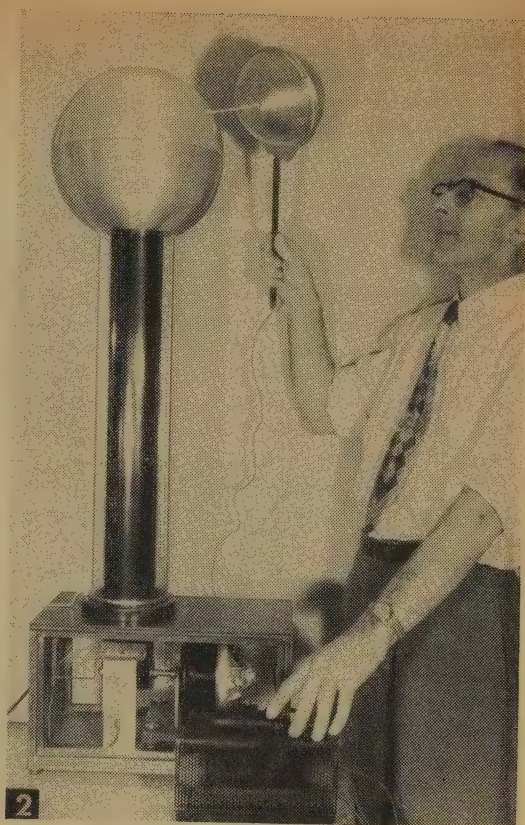
The small counterpart of these Van de Graaff generators will perform a variety of experiments (Fig. 1) and develop up to 380,000 volts under ideal atmospheric conditions. Dampness in the air reduces the efficiency of the unit causing leaks of the static charges from the belt, the column and the sphere to the air. When this unit was tested at the high-voltage laboratory of a large university in dry air, the short-circuit current was 18 microamps at the calculated voltage.

The high voltages generated are not usually dangerous, although you can feel a good sting if sparks jump to your fingertips when held too close to the ball. There is no electrical power

supplied to the belt; it picks up charges as the velvet rubs over plastic. Static charges on the surface of the plastic are positive and attract negative charges from the ground through a brush near the bottom end of the belt. These negative charges are carried upward on the moving belt, picked off by one of the two brushes in the top and carried to the surface of the sphere through the corona gap. The other brush is called the charging brush because it insures a positive polarity of the belt on the way down (Fig. 3). After a few minutes of operation, voltage builds up on the sphere to the maximum possible with the insulation provided and atmospheric conditions present. The model stands $39\frac{1}{2}$ in. high and only weighs 18 pounds. The only requirement for operating it is a 115-volt a-c or d-c outlet for the motor.

An inexpensive motor for driving the belt can be salvaged from an old Hoover vacuum cleaner. A slide-wire resistor or rheostat controls the speed to around 3000-4000 rpm. These motors are usually available at repair shops for \$5 or \$6 and develop about 1/4 hp. Be sure to select one with tight bearings that runs fast, smooth and without excessive sparking. It's a good idea to disassemble the motor, clean out dirt and old oil first. While the armature is out, turn the threaded end of the shaft to a 1/4-in. diameter (Fig. 5). To reverse the direction of rotation to drive the vel-

Table-top Van de Graaff throws heavy, noisy discharge to hand electrode up to 5 in. or thinner discharges up to 8 or 10 in. This model simulates the full-size generators that helped in atomic research.



A plywood cabinet encloses the motor and the base of the plastic column (Fig. 4). The motor mounts on two angle brackets bent up from $\frac{3}{16}$ x $\frac{3}{4}$ -in. mild steel or aluminum. Make a base for the motor from $\frac{1}{2}$ -in. birch plywood and mount it on large rubber knobs at the four corners to reduce vibration and to allow the belt to be tightened by compressing the rubber. Adjust compression on rubber mounts to align pulley.

A turned hardwood ring with its inside diameter of about $4\frac{7}{16}$ in. should be a tight fit around the Lucite column. Shellac or varnish makes an effective cement to hold the column in the ring. A flat copper wire (salvaged from the field winding of an old automobile starter) around the column keeps lower end of unit at ground potential.

The lower belt pulley mounts directly on the end of the motor shaft (Fig. 5). Turn a slight crown on the solid Lucite pulley to help keep the belt centered. Turn the center rod parts from brass stock and assemble pulley to the end of the motor shaft with set screw. Turning and center hole boring must be done accurately.

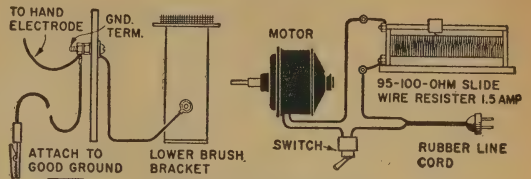
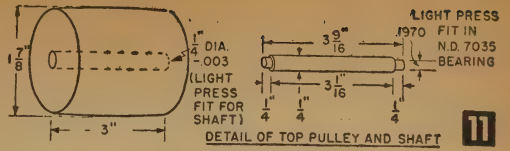
A bent-up piece of .064 aluminum supports the ground inductor brush (Fig. 6). Two pieces of copper screening, $\frac{1}{32}$ -in. mesh, give numerous arcing points and are adjusted with screws to about $\frac{1}{8}$ in. from the moving belt after it is in place.

A piece of Lucite sheet must be fitted inside the cabinet so the back of the belt rubs it (Fig. 7). Fit the Bakelite supports after the belt is in place.

When you complete the base cabinet, mount the driving motor, lower brush pickup and pulley, you're ready to add the top pulley assembly, make the belt and top sphere.

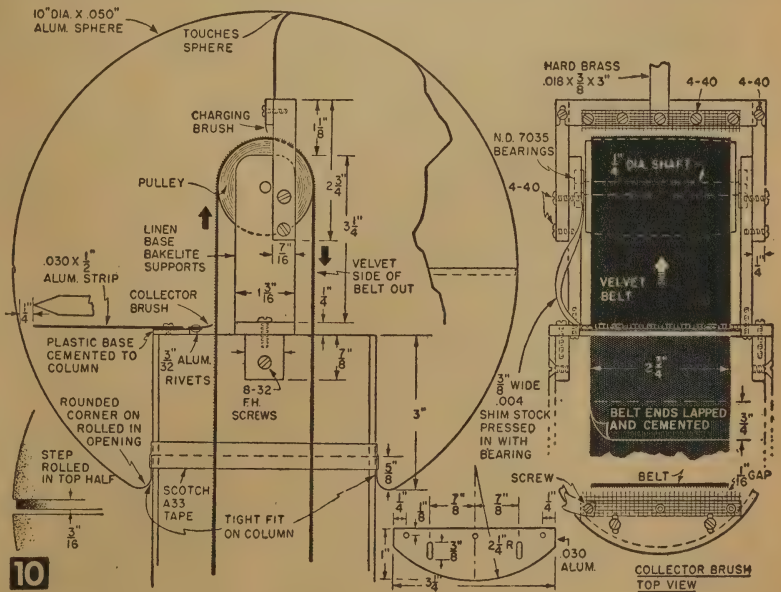
The top pulley and brush collector assembly inside the aluminum sphere mounts on two chunks of paperbase Bakelite screwed and Pliobond cemented to the inside of the Lucite column (Fig. 10). These blocks are curved to fit the column and must be mounted directly opposite each other and centered. The vertical U-supports that hold the top pulley must be bored for a press fit with the bearings. Use a $\frac{3}{4}$ -in. end cutting bit or end mill .0003-.0006 in. undersize in a drill press to bore out for the bearings. Or you may use a single lip type wood boring bit without a threaded center worm in a drill press if well sharpened.

Bore a $\frac{1}{4}$ -in. center hole about .0003 in. undersize in the piece of 2-in. dia. Lucite to be used for the top pulley for a press fit with the $\frac{1}{4}$ -in.



shaft, or you can drill a full-size $\frac{1}{4}$ -in. hole and turn a slightly oversize steel shaft for a press fit in the hole (Fig. 11). Cut bearing seats on the ends of the shaft for a light press fit in the bearings. Use the lathe cut-off tool to indicate length of the shaft, remove from lathe and remove the excess length; file ends smooth. Now, cut a piece of aluminum foil long enough to wrap around the pulley and lap $\frac{1}{16}$ in. Pliobond to pulley.

To assemble the upper pulley unit, press the bearings on the ends of the pulley shaft, then press the Bakelite side supports over the outer race of the bearings. The U-supports and the cross piece must be centered so the pulley is di-



rectly over and in alignment with the bottom pulley. A plumb bob or weight on a string helps to align the pulleys vertically, but be sure the bottom assembly is resting level. After locating the U-supports, screw them to the Bakelite cross piece and screw the cross piece to the blocks at the top of the column. The top pulley assembly will be removed later to slip on the belt.

MATERIALS LIST—VAN de GRAAFF GENERATOR

- Clear Lucite
1 tubing 26" long x $4\frac{1}{2}$ " dia. x $\frac{1}{8}$ " wall. May come about $4\frac{7}{16}$ " diameter actual measurement, column
2 solid rod stock 3" long x 2" dia., pulleys

- Natural paper base Bakelite
1 $\frac{1}{2}$ x $\frac{3}{4}$ x $3\frac{7}{8}$ " (Friction piece support in base)
1 $\frac{1}{4}$ x $\frac{5}{8}$ x $2\frac{1}{2}$ " (Friction piece support in base)
1 $\frac{1}{8}$ x $\frac{5}{8}$ x $2\frac{1}{2}$ " (Friction piece support in base)
Forest Products Company Inc., 131 Portland St., Cambridge, Mass. will supply the above material postage paid to any part of the U.S.

- 1 $\frac{1}{16}$ x 2 x $6\frac{1}{2}$ " alum. brush bracket (base)
1 .032 x $1\frac{3}{8}$ x $2\frac{3}{4}$ " alum. alloy (top of bracket)
2 $\frac{3}{16}$ x $\frac{3}{4}$ x $5\frac{1}{2}$ " mild steel motor angle brackets
1 $\frac{7}{16}$ " dia. x $1\frac{1}{16}$ " brass lower pulley
1 $\frac{5}{8}$ " dia. x $1\frac{3}{4}$ " brass lower pulley
1 $\frac{1}{2}$ " $8\frac{3}{8}$ x $14\frac{5}{8}$ " birch plywood, cabinet
2 $\frac{7}{8}$ x $8\frac{3}{8}$ " birch plywood, cabinet
1 fir plywood $\frac{3}{4}$ x $8\frac{1}{2}$ x $14\frac{3}{4}$ " base
8 ft $\frac{3}{8}$ x $\frac{3}{8}$ " hardwood strip stock

Miscellaneous

- 4 rubber knobs or feet
4 rubber knobs about $\frac{3}{4}$ to 1" diameter for motor base
1 universal motor from an old Hoover vacuum cleaner
1 3 x 4" copper screening, preferably $\frac{1}{32}$ " mesh
1 flat copper wire from the field coil of an old auto starter, about 24" long, ground band around column

- | No. | Size and Material | Use |
|-----|--|----------------------------|
| 1 | $\frac{1}{8}$ x $\frac{1}{2}$ x $4\frac{1}{4}$ " sheet Lucite | top brush strip |
| 1 | $\frac{1}{8}$ x $\frac{3}{4}$ x $3\frac{1}{4}$ " sheet Lucite | brush base in top |
| 1 | $\frac{1}{4}$ x $1\frac{1}{16}$ x $4\frac{1}{2}$ " paper base Bakelite | top support |
| 2 | $\frac{1}{4}$ x $\frac{7}{16}$ x $2\frac{3}{4}$ " paper base Bakelite | side support |
| 2 | $\frac{1}{4}$ x $\frac{3}{4}$ x $7\frac{7}{8}$ " paper base Bakelite | blocks, top edge of column |

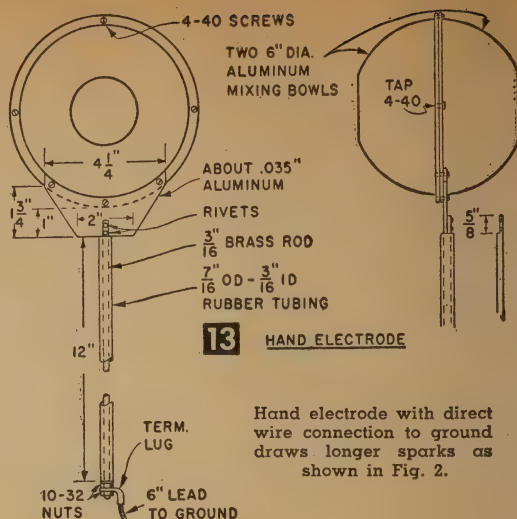
- 2 $\frac{1}{4}$ x $1\frac{1}{16}$ x $3\frac{1}{4}$ " linen base Bakelite
(Forest Products Company Inc., 131 Portland St., Cambridge, Mass. will supply the above material postpaid to any part of the U.S.)

- | | | |
|---|---|------------------|
| 1 | $\frac{1}{4}$ dia x $4\frac{1}{2}$ " cold rolled steel | top pulley shaft |
| 1 | .030 x $1\frac{1}{2}$ x $3\frac{1}{4}$ " sheet aluminum | side collector |
| 1 | .030 x $\frac{1}{2}$ x 3" sheet aluminum | brush base |
| 2 | 6" dia mixing bowls aluminum | corona gap strip |
| 1 | .050 x $1\frac{3}{4}$ x $4\frac{1}{4}$ " sheet aluminum | hand electrode |
| | | handle support, |
| | | hand electrode |

- | | | |
|---|---|---------------------------|
| 1 | 10" dia sphere, .050 alum. (available from Robert Towne, 49 Abbott Ave., Everett, Mass., \$8.25 ppd. in U.S.) | |
| 1 | .018 x $\frac{3}{8}$ x 3" hard brass sheet | connecting strip |
| 1 | .003 or .004 x $\frac{3}{8}$ x 4" shim stock | jumper to pulley |
| 1 | slide wire resistor or a rheostat 95-100 ohms, 1.5 to 2 amps | |
| 1 | S.P.S.T. toggle switch | |
| 1 | 2 $\frac{3}{4}$ " wide x 6' long velvet ribbon | belt |
| 2 | New Departure ball bearings #7035 (Available from Bearings Specialty Company, 665 Beacon Street, Boston, Mass.) | |
| 1 | $\frac{3}{16}$ dia x 13" long steel or brass rod | handle for hand electrode |
| 1 | $\frac{3}{16}$ I.D. x $\frac{1}{2}$ O.D. x 12" long rubber tubing | handle for hand electrode |
| | misc. wire, stain, shellac, screws, nuts, etc. | |
| | heavy duty aluminum foil, Pliobond cement | |

Velvet ribbon for the belt may usually be obtained from a large department store. You'll need about 6 ft. of $2\frac{3}{4}$ -in. ribbon of any color. To determine the exact length, run a string over both pulleys and allow about $\frac{3}{4}$ in. for lapping at the joint (Fig. 10). Apply a generous coating of Pliobond cement to both surfaces to be joined and clamp between two pieces of wood in C-clamps. Be careful not to allow cement outside of the lap area, or it will be difficult to separate from the wood later. Let the lap set overnight.

To install the belt, remove the top pulley as-

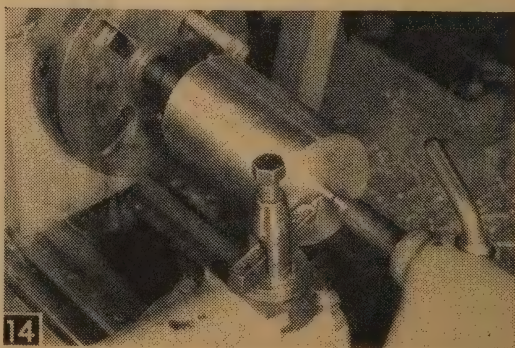


Hand electrode with direct wire connection to ground draws longer sparks as shown in Fig. 2.

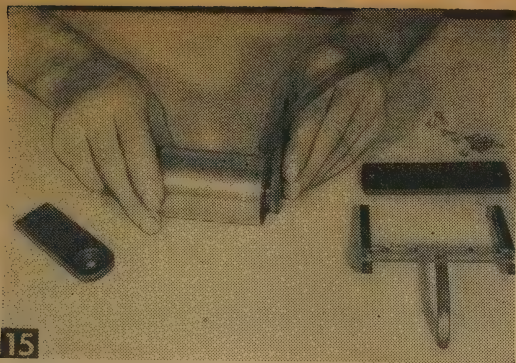
sembly at the two #6-32 screws and slip the unit through the loop of the belt. Tightening the base nuts maintains the reasonably tight tension required. When the belt is running straight and true, adjust the plastic piece in the base and fit the ground brush in place.

In case you have difficulty keeping the belt running true, there are several ways to correct misalignment. Thin shims of cardboard under either base end of the top pulley support or tightening front or rear motor bolts allow considerable adjustment. For further adjustment, the holes in the cabinet base can be slotted to permit shifting the motor as required.

The aluminum sphere is a metal spinning made according to Fig. 10. You should be able to have a local metal-spinning shop do the job for you, if not, you can get a sphere by mail from the source indicated in the Materials List. When spinning the turned-in neck that should fit tightly over the top end of the column, avoid any sharp corners or the built-up energy from the sphere will leak away. The seam between the two halves of the sphere should form a smooth joint to eliminate any edges where energy can leak off.



Machining shaft to be a light press fit in New Departure ball bearings 7035.



15 A strip of .003-in. brass shim stock is pressed in with bearing at left side (facing collector brush). After starting the bearings in their holes, an arbor press can be used to seat them. Note other top end parts.

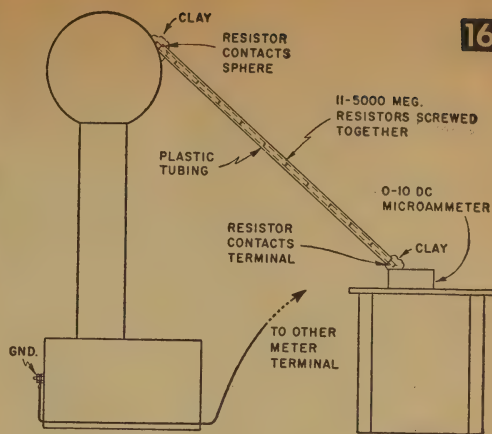
When the bottom half of the sphere is adjusted, fit the brush collectors and the spark gap strip at the top (Fig. 10). The wiring diagram (Fig. 12) shows the necessary connections with the slide-wire resistor or rheostat in the circuit to control the motor's speed.

When all parts are assembled and you're ready to make the initial test, run the motor up to about 3000 *rpm* with the top half of the sphere off. After a few minutes, you should be able to draw short sparks to your finger at the belt in the region between the brushes if the generator is working right. Possible causes for non operation may be that the plastic sheet in the base is not in full contact with the belt or too much humidity.

A final test is to set the half-sphere on top and connect a d-c microammeter between the sphere's surface and the ground terminal. A small chunk of modeling clay will plaster the top lead to the sphere's surface. Start the motor and, after a few moments' operation, you should read 15-20 microamperes, the short-circuit current of the unit.

To test the voltage output of the generator, connect a string of eleven 5000-megohm special high-voltage resistors (Type BBV, available from Resistance Products Co., Harrisburg, Pa.) by screwing their ends together (Fig. 16). Connect the series resistor string to one terminal of a 0-10 d-c microammeter away from the generator, using modeling clay to hold it in constant contact with meter terminal. Attach other end of the resistor string to the sphere with clay. Enclose the resistors in a tube of plastic or other insulation. The other terminal of the meter is connected to the ground terminal of the generator. You might be able to test your generator in a nearby university or electrical testing laboratory which would probably have the special resistors and microammeter.

When you complete the voltage test set up, run the motor at about 3000 *rpm* for a few minutes to allow voltage to build up on the sphere. Depending upon the humidity conditions in your test room, you should be able to read from 6 to 8 microamperes. If the meter's needle fluctuates wildly, it probably indicates the plastic piece is



Set up of resistors and microammeter for checking voltage of generator. It will vary with humidity.

not making full contact with the back of the belt. Good contact between the sphere's surface and the resistor string and at the meter is also important for correct readings.

When you read the current on the meter, calculate the voltage using Ohm's law ($E = I \times R$, where E represents voltage, I the current in amperes and R the resistance in ohms). One micro-ampere is one millionth of an ampere, so 7 microamperes becomes .000007 amperes. One megohm equals 1,000,000 ohms and 55,000 megohms converts to 55,000,000,000 ohms. Completing the calculation shows the voltage at a current reading of 7 microamperes is 385,000 volts.

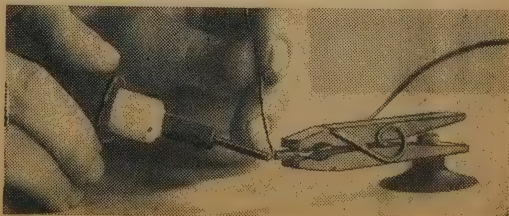
The hand electrode (Fig. 13) capacitor aids in experimenting with the Van de Graaff generator. It should be possible to get satisfactory discharges at speeds as low as 1000 *rpm*.

Foil Aids Set Alignment

- To avoid interference, it is common practice to stop a superhet's oscillator before aligning the intermediate-frequency amplifiers. A simple way to do this, is to wedge a piece of aluminum foil between the plates of the oscillator's tuning capacitor. When the dial is rotated, the foil between the rotor plates makes contact with the stator plates and "kills" the oscillator.

The Radioman's Third Hand

- A wood clip-type clothespin fastened to tabletop by a suction cup makes a handy holder for soldering of eyelets, terminals and lugs.



Build An Emitter Follower!

You can couple low-impedance devices to high-impedance circuits with this emitter follower. The unit can be built in a few hours for about \$3

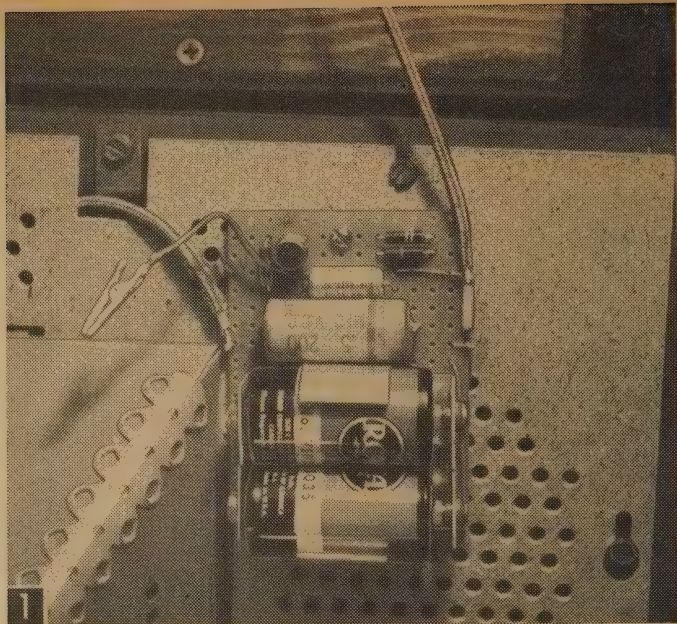
By FORREST H. FRANTZ, Sr.

ELECTRONIC experimenters and hi-fi enthusiasts frequently need to connect a low-impedance load to a high-impedance output. Typical applications are coupling a low-impedance microphone or phono pick-up, or using a low-impedance meter to measure voltages in a high-impedance circuit. An emitter follower will do the job.

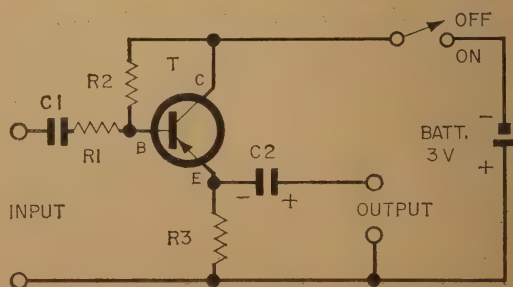
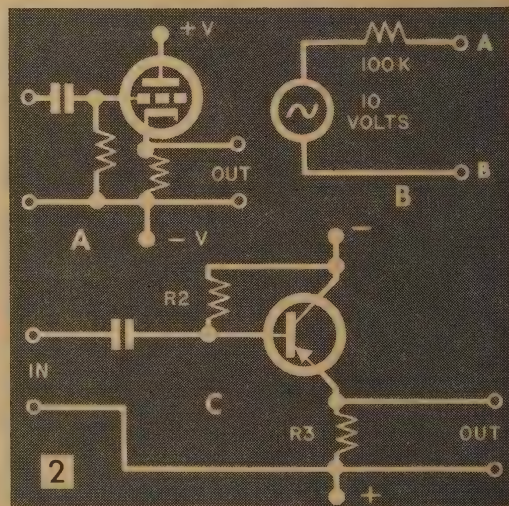
Sometimes the problem of coupling high impedance devices separated by considerable distance crops up because the capacitance between the connecting wire center lead and shield is sufficiently large to affect the frequency response of the system. If an emitter follower is connected in the line, the problem can be licked.

The emitter follower described in this article is relatively small in spite of the fact that no special effort was made to miniaturize it. Flashlight batteries were employed as a power source to obtain operating economy. The current drain on these batteries is less than 1 milliamper.

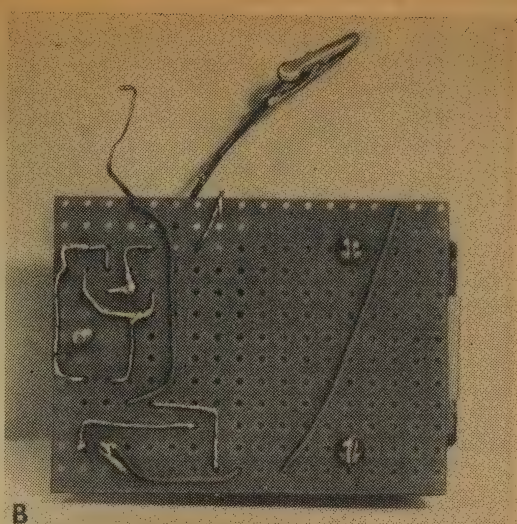
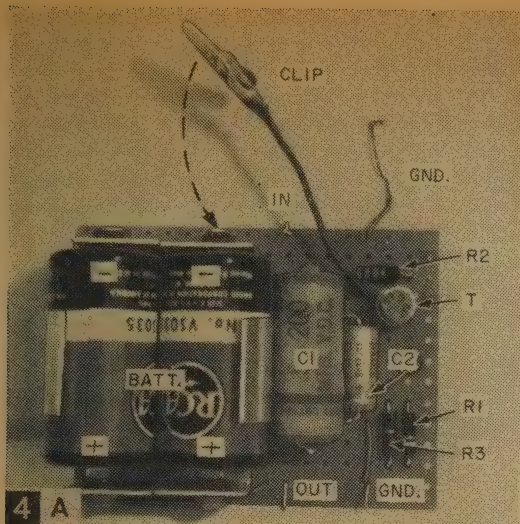
The emitter follower is the transistor equivalent of the vacuum-tube cathode follower. The voltage gain of a cathode follower is approximately unity. A simplified vacuum tube cathode follower circuit is shown in Fig. 2A. The input impedance of a cathode follower is high (several megohms), but the output impedance is low (several hundred ohms). Thus, if a low-impedance device such as the ac voltmeter section of a multimeter is to be used to measure ac voltage in a high-impedance circuit, it can be connected to the output terminals and the



An emitter follower can be used to connect the audio of a radio or TV set to a hi-fi amplifier. If back of set is metal, insulate back of emitter follower.



3 SCHEMATIC



Front (A) and back (B) views of follower's parts placement and wiring.

input terminals of the cathode follower become high-impedance input terminals for the meter. Probe leads connected to these input terminals can be connected across high-impedance circuits without loading them significantly.

If, on the other hand, the low-impedance ac voltmeter section of the multimeter were placed across a high-impedance circuit, the circuit would be—for all practical purposes—shorted, and the voltage indicated on the meter would be very low. In addition to causing a low meter reading, the near-short circuit would affect the operation of the circuit under test. An example will illustrate this more clearly:

Assume that the voltage across terminals A and B in Fig. 2B is to be measured. If a meter with 5K impedance (1000 ohms per volt set to the 5-volt scale) is connected across terminals A and B, it will measure $5/(100 + 5)$ or $1/21$ of the 10 volts. However, if the meter is connected to the output terminals of the cathode follower, and the input terminals of the cathode follower are connected across terminals A and B, the meter will read nearly 10 volts. Assuming the input impedance of the cathode follower to be 10 megohms, the voltage across the cathode follower input is $10 \times 10/10.1$, which is nearly 10.

The cathode follower unfortunately has the drawbacks associated with a vacuum-tube circuit: high voltage supply requirements, wasted power and large size.

An emitter follower is free of these drawbacks, but there are some differences between it and the cathode follower. The circuit of a simplified emitter follower is shown in Fig. 2C. The input impedance of this emitter follower would be approximately equal to beta times R3, if R2 were not present. The

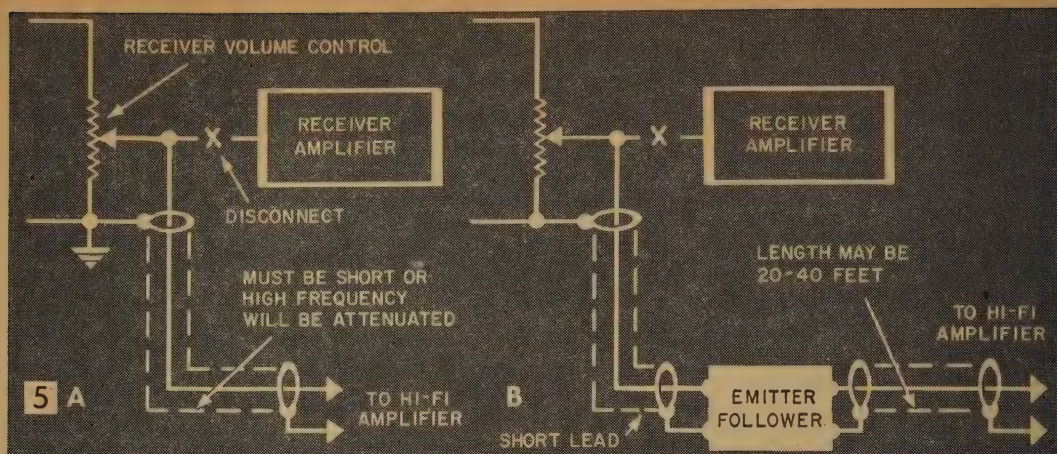
MATERIALS LIST—EMITTER FOLLOWER	
Desig.	Description
R3	2.2K, $\frac{1}{2}$ watt carbon resistor
R2	220K, $\frac{1}{2}$ watt carbon resistor
R1	470K, $\frac{1}{2}$ watt carbon resistor
C1	.5 mfd, 200 v paper capacitor (Sprague 2EP-P50)
C2	30 mfd, 15 v miniature electrolytic capacitor (Sprague TE-1158 Littl Lytic)
B	two 1.5-v flashlight cells (RCA VS035 or Burgess No. 1)
	two cell battery holder (Lafayette MS-174)
	$27/16 \times 33/8$ " miniature perforated board (Lafayette MS-304)
T	minigator clip (Mueller 30)
	2N362 Raytheon transistor (or any PNP transistor, see text)

Components may be obtained from Lafayette Radio, 165-09 Liberty Ave., Jamaica 33, New York.

beta of the transistor is the current gain, and for the better audio driver transistors, beta is around 100. Then, if R3 is 1K, the input impedance of the emitter follower would be about 100K if R2 could be neglected. But R2 acts in shunt with the input signal, and therefore if R2 is about 200K (this is a practical approximation), the input impedance would be about 67K.

It might seem that the input impedance could be increased considerably by increasing R3. Suppose R3 were 10K. Then, if R2 could be neglected, the input impedance would be 1 megohm! Now, assuming that R2 can be 1 megohm, the input impedance becomes $\frac{1}{2}$ megohm or 500K. Unfortunately, the size of the battery must be increased (greater voltage required) to use such values. Furthermore, the previous 1K output impedance has been increased to about 10K. This is a relatively high impedance in itself.

The Circuit that was chosen for the practical emitter follower described in this article is shown in Fig. 3. This circuit contains the compromises between voltage and circuit values that produce a high ratio of input to output impedance and relatively good frequency response. Resistor R3 was chosen as



2.2K; R2 was chosen as 220K. A series resistance R1 was added to increase the input impedance. In the original model, this resistor was 470K. The input impedance of the amplifier without this resistance was about 100K with a gain of unity. With R1 in the circuit and equal to 470K, the voltage gain was about 1/6, and the input impedance was about 570K. If R1 is 100K, the input impedance is about 200K, and voltage gain is about 1/2.

If a lower beta transistor such as a Raytheon CK722 or a GE2N107 is substituted for the higher beta 2N362 used in the original model, the input impedance of the emitter follower without R1 in the circuit will decrease to about 40K. Now if R1 is made equal to 40K, the input impedance of the unit will be 80K and the voltage gain will be 1/2. If R1 is 200K, the input impedance will be 240K and the voltage gain will be 1/5. It is easy to see that any PNP transistor that you might have will work in this circuit, but some performance is lost with lower beta transistors.

The front and back views of the emitter follower are shown in Fig. 4. The emitter follower is constructed on a perforated Bakelite board. The on-off switch is a Minigator clip which is connected to the unconnected battery holder lug to turn the emitter follower on. Two flashlight cells connected in series furnish the 3 volts required to power the emitter follower. The input capacitor C1 is 200-v paper capacitor which permits connecting the emitter follower to vacuum-tube circuits. The output capacitor C2 is a 30 mfd. electrolytic capacitor rated at 15 v. If you intend to couple into a circuit that has high voltage present, a higher voltage rating is required for this capacitor, but most circuits that you'll couple to won't have high voltage present.

To construct the emitter follower, drill the two battery mounting holes and the third mounting hole. This third hole has been provided to allow the emitter follower to be

bolted down on other electronic equipment for permanent or semi-permanent installation.

Next, mount the battery holder. Then place all of the parts on the board as shown in Fig. 4 by inserting the pigtails through appropriate holes in the board. Then turn the board over and use Figs. 3 and 4 to guide you in wiring. Most of the connections are made with the pigtails of the component parts. The pigtails are bent against the board, and whenever a connection is to be made, the wires are run against each other and soldered.

Input and output terminals consist simply of pigtail or wire ends to which Minigator clip leads may be connected on the original model. If you wish, you may provide wire leads with clips on the ends, or you may provide terminals on the model. The input leads should be shielded. Output leads must not be shielded unless a long length of connecting wire is involved.

The emitter follower will permit two high-impedance devices that are separated by a great distance to be connected together without high frequency attenuation. You might, for example, wish to use an inexpensive table radio as a tuner with a hi-fi amplifier since the tone quality of most inexpensive radios is quite poor. If you disconnect the radio audio amplifier from the center lug of the volume control and run a shielded lead to the amplifier as shown in Fig. 5A, you've converted the radio into a tuner for your hi-fi amplifier.

But, if the shielded lead is over, say, a foot or two long, it will attenuate the high frequencies due to the inherent capacitance of the shielded lead required to minimize ac hum voltage pick-up. If the capacitance of the shielded lead was in parallel with a low impedance such as that of the emitter follower output, the frequency response would remain relatively flat. Such an arrangement is shown in Fig. 5B.

Magic Light Bulb

THIS 60 watt Mazda bulb, removed from a light socket, glows when held in the fingertips or mouth, and when placed on a suspended pane of glass. Of course, it takes a little doctoring to make it work this way. First remove the "innards" from a burned-out 60 watt frosted bulb. With pliers, crush the black composition at tip of lamp base (Fig. 2). Shake out composition and remove brass button. With brass shell opening clear, insert plier handle and tap sharply, thus breaking off glass stem inside lamp (Fig. 3). Pull out glass stem and burned out filament through open-

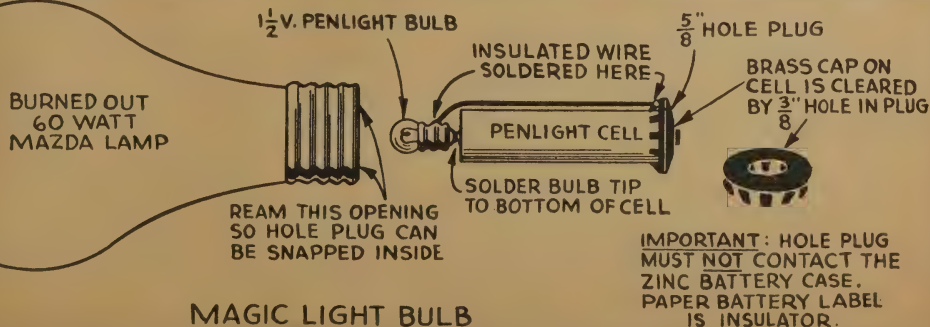
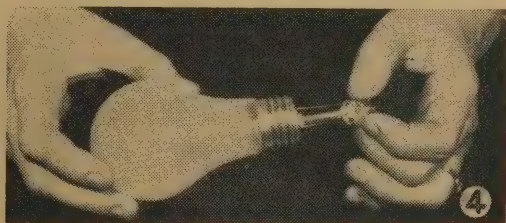
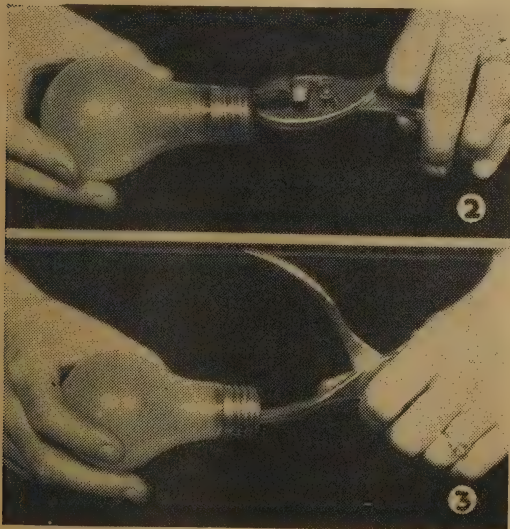


ing in bottom of brass screw base (Fig. 4).

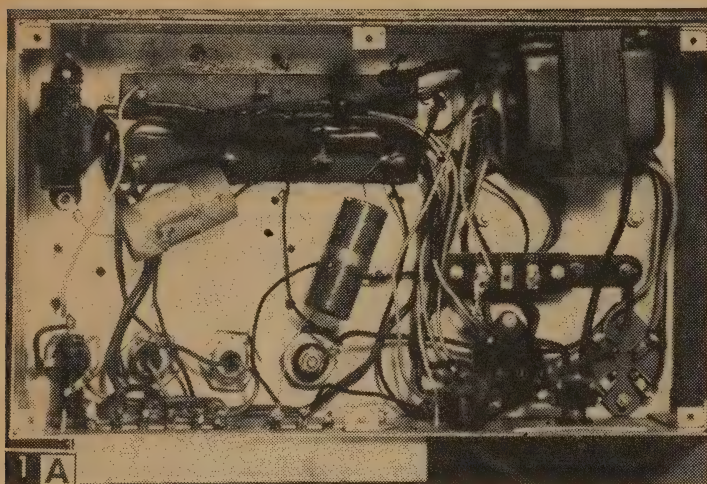
Obtain an anodized hole plug at an auto accessory or radio supply store, and a $1\frac{1}{2}$ volt penlight bulb and a penlight battery. Cut a $\frac{3}{8}$ in. hole in the hole plug. Insert pen-cell into plug, brass tip down. Solder tip of bulb to bottom of battery. Connect thin insulated wire from brass shell of penlight bulb to brass shell of hollowed out Mazda bulb. Ream base with closed scissors to admit battery and insert penlight cell assembly into bottom of lamp base (as shown in drawing).

So trick will look natural, insert bulb into a lamp which has been disconnected from the house current. When occasion arises, remove bulb from socket,

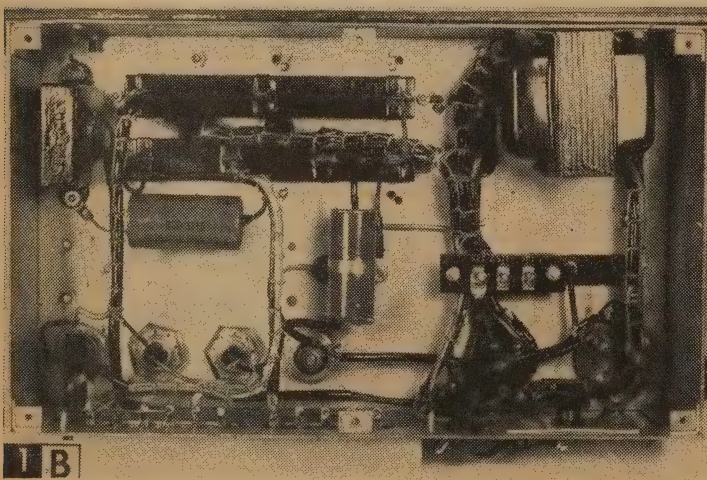
and hold it in your fingers. Press a dime, small paper clip or pin concealed in your hand against bottom of bulb. This completes circuit from center cap of inverted pen cell to outer brass shell of Mazda lamp and bulb lights up. A paper clip concealed under tongue may be used to light the bulb when held in the teeth. To light bulb in porcelain cleat socket with no connections and resting on a suspended pane of glass (Fig. 1), simply previously short-circuit the two screw terminals on socket with a piece of fine wire.—
R. R. DOISTER.



Professional Electronic Wiring



A general-purpose power supply is shown scramble-wired above. While it works, it looks bad and is difficult to troubleshoot. The same power supply is shown cleaned up below. An even more workmanlike job would have resulted if the builder had been willing to rewire the unit completely.



By HOWARD S. PYLE

WHETHER you build hi-fi or amateur radio equipment, you want gear you can point to with pride. What you are building is something which you expect to be more or less permanent. If and when you have occasion to abandon it, you can ask, and receive a far better price if your wiring, as reflected by your terminal connections and other circuitry, are of professional appearance and workmanship. Fig. 1A shows a "hay-wire" method of termination; Fig. 1B is the professional version. Which of the two

would attract *your* cold, hard cash.

Figures 2, 3, 4 and 5 illustrate the method of accomplishing the professional touch shown in Fig. 1B. A final touch of spit-and-polish can be given by applying a generous coating of clear lacquer (such as Fuller's ANL-232 "Synalac") over wire, sleeving and number tape.

A slack loop consists of nothing more than an excess wire length of 2 or 3 in. at the terminal, where it is formed into either a horseshoe or a complete circle. Use a 1/2-in. or 3/4-in. wooden dowel to form your circles. Slack loops serve two purposes: they provide sufficient slack in the wire to permit rerouting it to an adjacent terminal in the event of later modification in circuitry and they provide for re-termination to the same terminal without a short splice in case a wire breaks at a lug or soldered connection.

Shielded wire, one or more insulated conductors enclosed in a cross-hatch weave of tinned copper, is used in both radio and audio frequency applications to prevent stray radiation of RF fields and to avoid pick-up of ac hum and similar disturbing influences on audio leads. Grid wiring to vacuum electron tubes is particularly susceptible to such undesirable influences which then are amplified in the tube; microphone wiring should *always* be in shielded conductors. Frequently the shield itself is used with microphones of the "push-to-talk" variety with a built-in switch. The shield then becomes common and forms part of both the switch and microphone circuits.

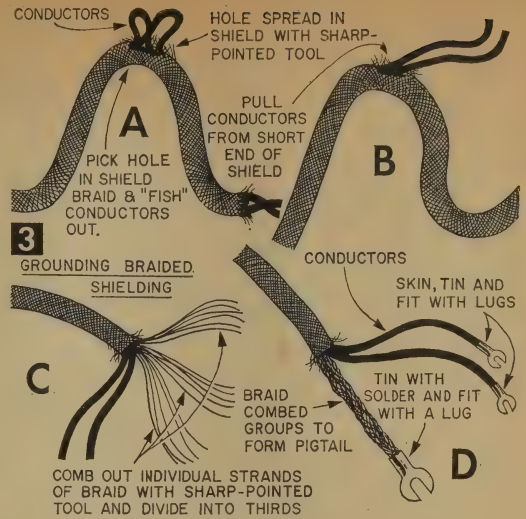
Before the advent of plastic insulated conductors, it was possible, by skillful handling, to run a small solder "collar" around the

end of the shielded braid—even include a short length of wire in the collar which could be used to terminate the shield on a chassis ground-point. This is still possible when the conductors themselves are fabric insulated, but not so with plastic which will melt completely with application of sufficient heat to the shield to permit a hot solder joint.

The answer? Well, if the shield is merely to be ended or tied-off without grounding, put a drop of liquid solder or aluminum (both applied cold) on the end of the braid and form it smoothly with your fingers to make a solid collar. Such a collar will set up hard in a few minutes and requires no heat, hence there is no damage to insulation. I use either Warner's Liquid Solder or Duro Liquid Aluminum.

As an alternate method of avoiding fray at the end of shielding, you can pinch the shield between spaghetti sleeving. The sleeve that goes over the conductors; the inner sleeve, should be a snug fit, and still capable of being pushed up *under* the shield braid; the outer sleeve must be of an inside diameter which will permit sliding over both the shielded braid and the spaghetti on the conductors.

Suppose, however, that you do have to ground the shield at either or both ends. Liquid solders are a mechanical binder only and should not be relied on for electrical connections. A far better method is to form a pig-tail directly with the end of the braid itself. This can be done neatly and effectively by following the steps illustrated in Fig. 3. First, push the shield back up the wire to form a bulge or hump in the shielding by working the braid apart. Using the same tool, pick the conductors out of the shielding, one at a time in small loops. Once you have them within easy finger grasp, withdraw them completely from the short end of the

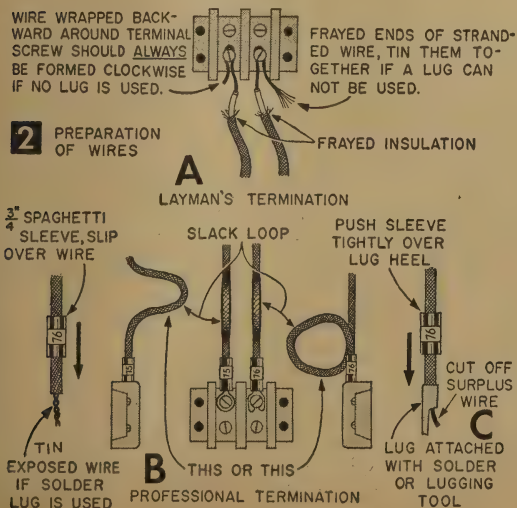


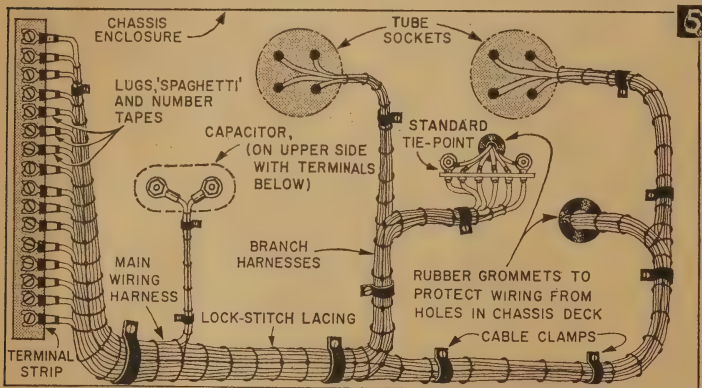
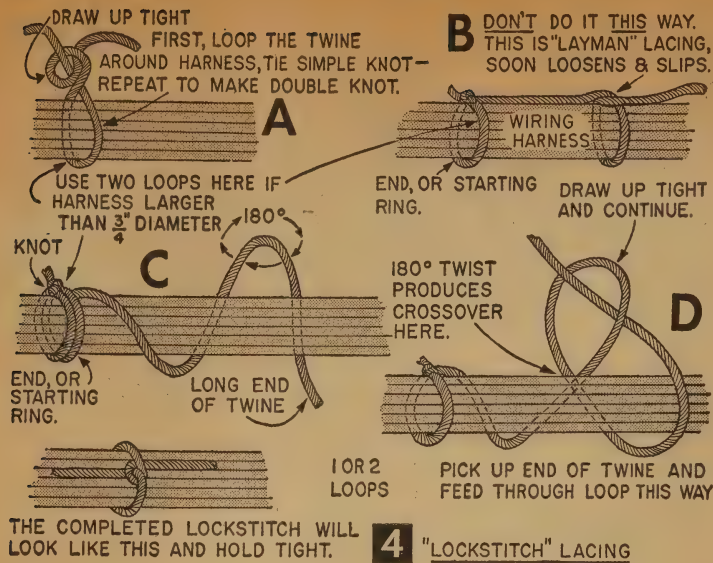
shield.

Next, separate the wires of the shield which will form the short pig-tail by using the pick or a nail to unbraid the web. Divide the resulting individual wires into approximate thirds and braid them tightly like a small girl's hairdo. Seal the end of the pig-tail with a spot of hot solder and fit it with a lug, either the solder type or solderless, as you prefer.

Cabling and Lacing. In forming your wiring prior to cabling and lacing, do not attempt to run wires from point-to-point by the shortest route. Except in a few isolated instances (high-frequency carriers, for example), whether a wire is 5 in. long or 7 in. long is of no consequence. Using that reasoning, you will be able to form your wires to follow the line of the chassis, making short, rounded 90° turns at the corners and at branches leaving the main cable harness. If, by extending some individual wire for a few inches you can include it in a main cable harness, do so. If you are careful to use shielded wire wherever the schematic you are working from specifies, or, if not so designated, wherever you are carrying radio or audio frequency such as microphone and speaker leads and wiring to the grid circuits of vacuum tubes, you'll have no trouble. See that all such shielded wires are solidly grounded to the chassis at both ends either by the pig-tail method of Fig. 3 or by small wiring clamps screwed to the chassis.

Now to the actual cabling and lacing. Obviously if you are to run in one harness a number of wires that will terminate at scattered points, each wire will be of a different length. Be sure that each is long enough or you'll have the tedious job of unlacing all of your harness to replace the short wire. You can cut to exact length when you come to the point of actual termination but better to





begin by making each wire a few inches longer than necessary.

In some instances you can completely pre-form your harness, including the lacing, right on the bench and have it fall in proper place in your chassis. Where chassis layout makes such pre-fabrication of a harness impossible, it will be necessary to place each individual wire in proper position in the chassis, routing each one carefully alongside the others with which it is to be cabled and making the final termination at each end. Hold the bundle in place temporarily with a few ties here and there to maintain the final harness form. Then, when all wiring for that particular harness run is complete, lace it in place in the chassis.

One tip on pre-fabrication: use different colored wires for ready identification individually at each end of the harness. If your available wire stock is insufficient to permit this color coding, mark both ends of each wire with adhesive number tapes or tags. Some craftsmen

prefer to "ring out" each individual wire with a buzzer or an ohmmeter as a double-check, when terminating.

Professional practice dictates the use of "lock-stitch" which, while really simple, almost defies written description (see Fig. 4). Start your lacing about an inch from the main termination point of your harness... a connection block for instance. If it is a harness of relatively few small wires, space the twine rings around the harness about $\frac{1}{2}$ in. apart. If it is a larger number of heavier wires, 1-in. spacing will be adequate. Multi-wire harnesses of more than 1-in. cross-section can be laced every 2 in., but if 6-cord lacing twine is used it should be doubled for added strength.

A good rule to follow is to space the twine rings for a distance about equal to the dia. of the bundled harness and use the twine doubled on any harness over 1 in. Tie-off the ends, both at the starting point of the lacing and at completion, with an ordinary square knot, double tied.

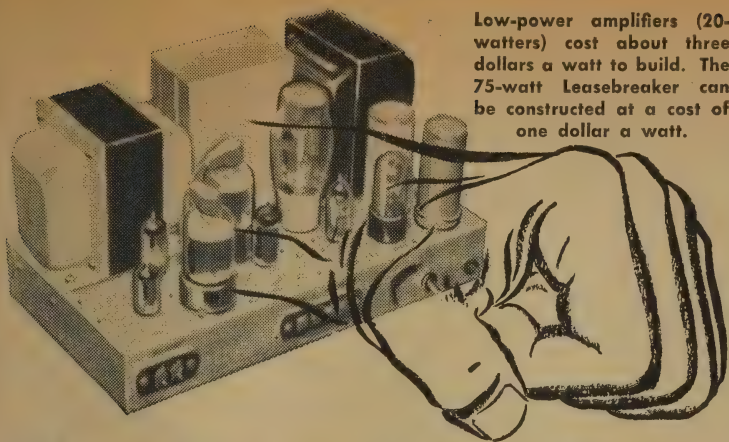
Chassis wiring by the cabled and laced method does not mean that all wires of the harness will terminate in the same area at each end.

There will be considerable branch wiring from the main harness trunk. As your lacing progresses, you reach various points where one or more wires leave the harness to connect to an adjacent component.

At this point, wrap the twine ring twice around the main harness and bend the wires leaving the harness 90° toward the terminals to which they will connect. Then proceed with your lacing to the next branch. This will result in a tapered harness (see Fig. 5).

Answers to Photo Quiz on Page 103

1. Rotary wafer switch.
2. Roll of electrician's rubber tape.
3. Pilot lamp.
4. TV lead-in stand-off insulator.
5. Top of spray can of service chemical.
6. Diagonal cutters.



Low-power amplifiers (20-watters) cost about three dollars a watt to build. The 75-watt Leasebreaker can be constructed at a cost of one dollar a watt.

little job with enough wallop to enable anyone to break his lease by popular request within three minutes! Whether or not that is your projected use for it, this amplifier will deliver—subject to rising costs and picking up a few good buys—one watt of power per dollar of construction cost.

It is an engineering maxim that when cost is an object, no element of a system should be unduly stronger, or unduly weaker, than any other. There is no sense in paying for performance that cannot be utilized. At the outset, we gained considerable simplification in design by deciding that the amplifier would be used only to handle program material and not sinusoidal signals. This is a compromise that has been used for years in the design of modulators for high power AM transmitters.

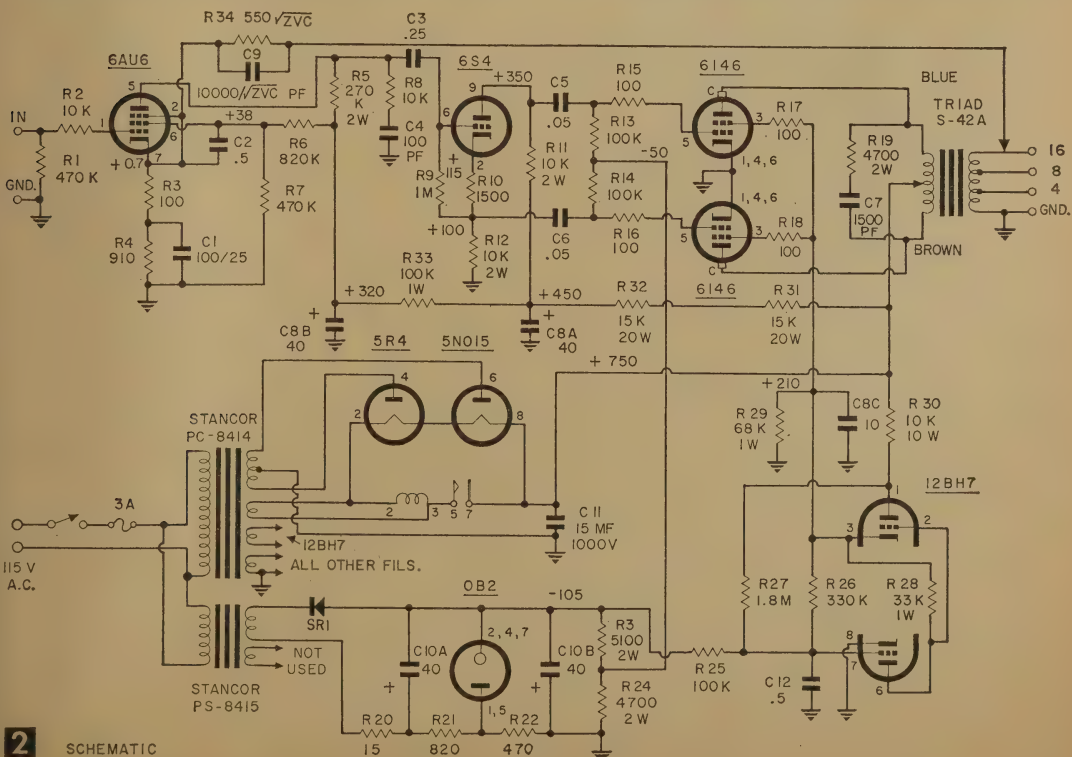
The Leasebreaker

Not the perfect amplifier—that hasn't been built—but an outstanding bargain in high-power amplifiers. Net price, including tubes, is \$75—or a dollar per watt

By LEE/SHERIDAN

WHEN we decided we needed a new amplifier we knew we wanted the greatest possible power output per dollar of cost. What we achieved was a dandy

ters. Since a sine wave contains much more average energy than does program material of the same peak amplitude, it is permissible to use much lighter components than would



be required for continuous sine-wave operation. It's only necessary that components be capable of handling the occasional peaks in program material.

For the amplifier, we felt that the simplest configuration would be a pentode gain stage, a split-load phase inverter, and the output stage. For the gain stage, a 6AU6 vacuum tube is excellent, very low in noise and capable of high gain. In our circuit, it provides a gain of 200, with well over 200-v peak-to-peak of signal delivered to the following stage.

A 6S4 is used for the phase inverter; set to draw 10 milliamperes, it can deliver 150 v peak-to-peak at the output grids, which require about 100 v for full output. The heavy degeneration provides a very high impedance for the 6AU6 to work into, thus raising its gain—while the 6S4 presents a fairly low driving impedance to the output grids.

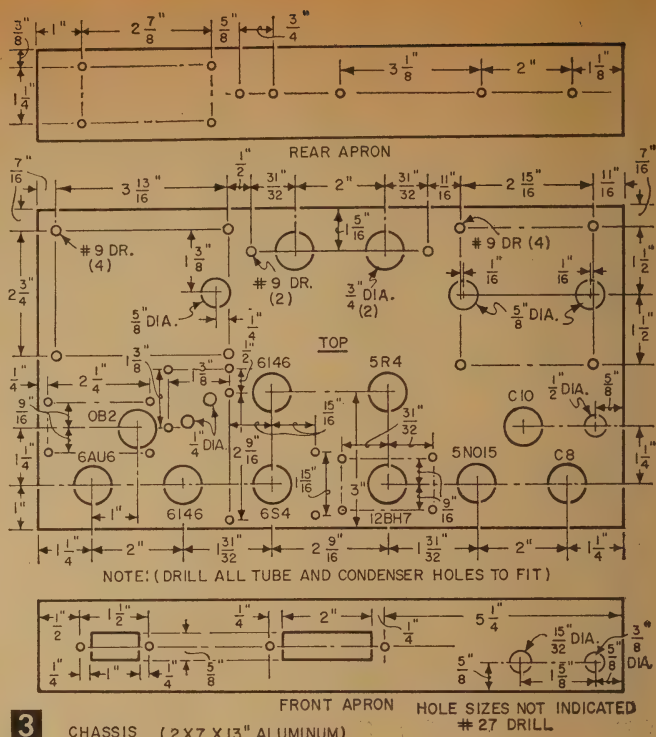
But if the amplifier is to be stable under feedback, it must be "tamed." At the high-frequency end, this poses a problem due to the low resonant frequency of the output transformer. We solved this problem by the joint action of three devices: a series RC (R8 and C4, see Fig. 2) from plate to ground in the first stage, another across the primary of the output transformer (R19 and C7), and the customary capacitor (C9) across the feedback resistor (R34).

Low-frequency stabilization is also achieved by the use of a cathode capacitor in the input stage, coupling capacitors and grid resistors feeding the output stage, and the falling response of the output transformer itself.

In consequence, The Leasebreaker is so stable that the removal of the load has absolutely no effect on frequency response!

We consider that *any* rise in response at the end of the passband is the mark of an unstable amplifier—and judging from what we've seen, unstable amplifiers are in the majority today. Our Leasebreaker, however, employs 20 db of feedback overall, and the response at the ends of the passband is never anything but a smooth drop below 20 cycles and from 20 kc out to 500 kc. At this point, there is a slight resonance, but the response is over 30 db down from midband. No value of capacity up to 10 mfd produced oscillation when shunted across the 16-ohm load.

Think we're making too much ado about this business of stability? Remember—an amplifier of this power capacity (75 watts) can, if it runs away, ruin a speaker in just a few seconds!

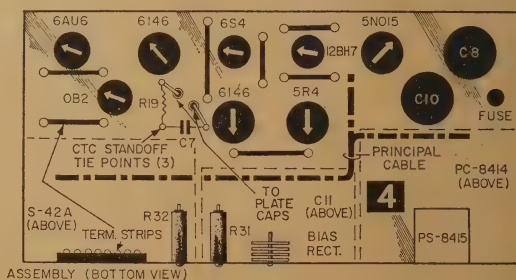


3

CHASSIS

(2X7 X 13" ALUMINUM)

HOLE SIZES NOT INDICATED
#27 DRILL

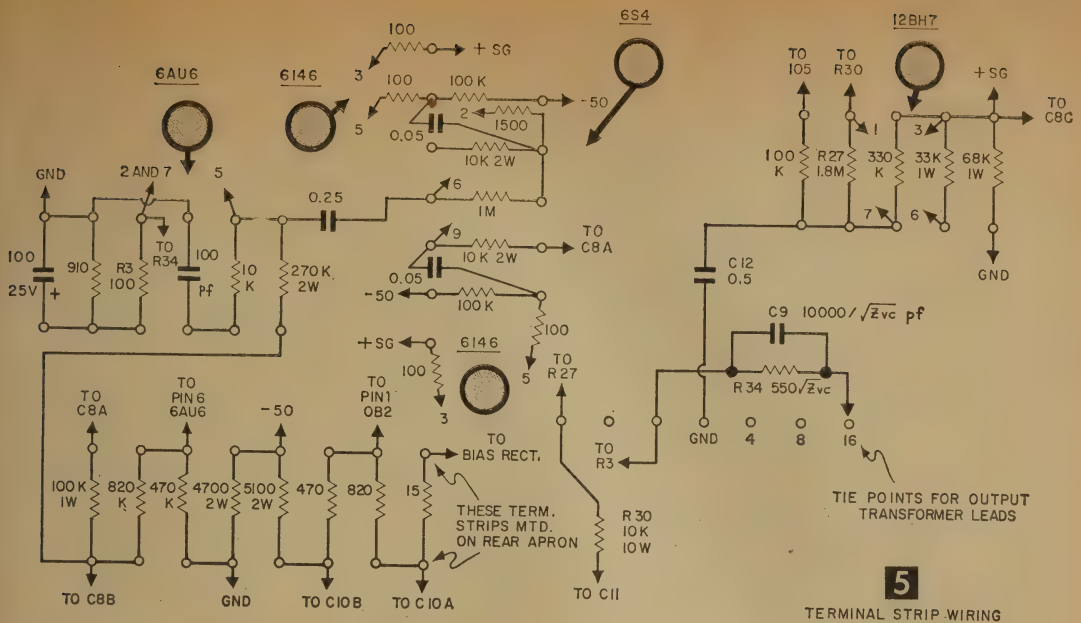


ASSEMBLY (BOTTOM VIEW)

The power supply. We used a Stancor PC-8414 transformer, which delivers 600 volts on each side of center at 200 mils. While this would overheat badly if the amplifier were driven to full output continuously by a sinusoidal signal, it's perfectly capable of handling occasional high level peaks.

For the rectifier, we think there's no argument about a 5R4, and one tube is adequate. A single 15 mfd, 1000-v oil slug (C11) is used in the high-voltage section. The ripple here is distressing (35 v peak-to-peak quiescent, rising to 75 v at full load), but a 40-40-10 mfd, 450-v electrolytic capacitor (C8) provides the filtering necessary for lower level stages and the screens of the output stage.

To protect the electrolytic capacitors and to make things easier on the tubes by giving the heaters a chance to come up to operating temperature before the high voltage hits, we used an Amperite thermostatic delay relay—with a 5-v heater so there is no potential difference



TERMINAL STRIP WIRING

between heater and contacts. We preferred the octal-based relay to the miniature for this job because the octal socket provides a longer flashover path to ground than does the miniature.

A simple bias supply is provided with a configuration which permits use of a dual 40 mfd can. An OB2 glow tube holds the bias voltage constant. With the values shown, it draws about 10 mils. Some selection of the 5100 and 4700 ohm resistors may be needed to get just exactly minus-50 volts at the tap, and these should be 2-watt units for best temperature stability.

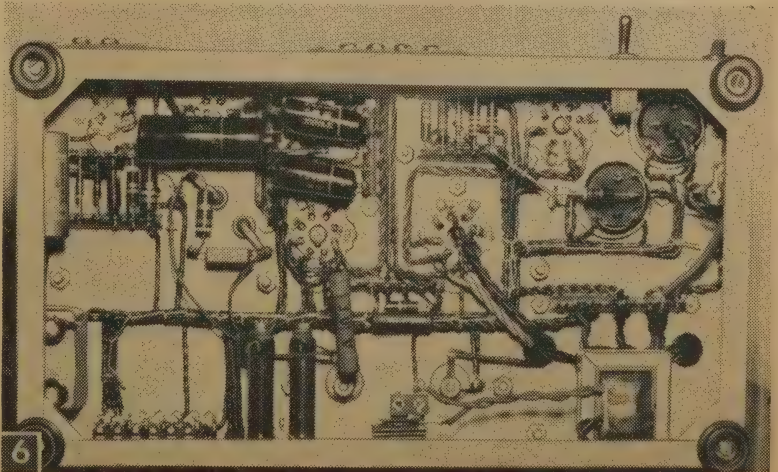
Screen regulation is an absolute necessity if maximum power is to be developed. We blithely started with VR tubes and encountered trouble! By the time the screens are stabilized the tubes are beyond their ratings when there's no signal. And there is also considerable additional heat dissipation.

So we cast about for a simple solution and came up with that shown in Fig. 2. Note that the conditions which increase the screen drain also pull down the supply voltage considerably, due to the poor high-voltage regulation.

The 12BH7 is a husky

twin triode, designed for use as a TV vertical deflection amplifier, with a 500-v plate voltage rating and a permissible dissipation of 3.5 watts per section. The two sections are connected in series, with the upper as pass tube and the lower as dc amplifier. The control voltage divider is returned to the minus-105-v bias supply, to keep the dc amplifier grid near ground, yet allow large swings.

In operation, this has proved an excellent little regulator, its output voltage being the same at full output as at zero signal, with a rise of about 10 v in the middle range. Initially, the output voltage had a tendency to drift with changes in line voltage, but the addition of R26 reduced this drift to an acceptable range. Correction is not complete, of course, because the dc amplifier does not have sufficient gain.



Bottom-chassis view of the Leasebreaker. (Photo was taken before addition of C12.)

Construction. We constructed The Leasebreaker compactly on a 2 x 7 x 13-in. chassis, and the large transformers and filter capacitor must butt against each other in order to fit (see Figs. 1, 3 and 4). Tubes and electrolytic capacitors are placed along the front, the 6146's being staggered, rather than side by side, to reduce the heat problem.

A neat terminal board effect is achieved through the use of Cinch-Jones 2000 series terminal strips mounted in parallel pairs (See Fig. 5). For the input stage, we used 2006's; a 2005 and 2007 for the phase inverter, 2005's for the screen regulator, and 2008's for mounting miscellaneous power supply resistors. This scheme is a real space saver, since tube sockets may easily be straddled.

The two 15K 20-watt dropping resistors are mounted with long screws through the back apron of the chassis. Be sure to use an insulated shoulder washer here and several insulated flat washers on each end!

Cinch type 2C7 sockets were used for the two electrolytic cans. Note that the outer contacts are tied together to make maximum use of contact area. The bias supply capacitor should be provided with an insulated sleeve, since its can is negative with respect to the chassis.

A double ground system is used to avoid hum troubles, for the charging current through the 15 mfd capacitor is quite high and can easily give trouble if it gets into a common ground bus. For this reason, a power supply ground is made right at the negative terminal of the 15-mfd capacitor to which transformers, electrolytic capacitors and 6146 cathodes are returned. A separate signal ground is made at the input terminals, to which all other grounds are returned through separate ground wires.

Good quality statite sockets should be used, at least for the rectifier and delay relay, since these parts carry the full 750 volts.

Use an aluminum chassis, be-

MATERIALS LIST—LEASEBREAKER

Desig.	Description
T1	45000 ohms plate-to-plate to 4, 8, 16 ohms (Triad S-42A)
T2	600-0-600v, 220ma; 5v, 3a; 2 x 6.3v, 3a (Stancor PC-8414)
T3	115v, 15ma; 6.3a, 0.6a (Stancor PS-8415, Triad R-54X)
V1	6AU6
V2	6S4
V3, V4	6146
V5	5R4
V6	0B2
V7	12BH7
V8	Amperite 5N015
SR1	50 ma, 115-v selenium rectifier
C1	100 mfd, 25-v electrolytic
C2	0.5 mfd, 600-v bathtub or 0.5 mfd, 400-v molded paper tubular
C3	0.25 mfd, 600-v molded paper tubular
C4	100 mmfd mica
C5, C6	0.05 mfd, 600-v molded paper tubular (matched, if possible)
C7	1500 mmfd, mica
C8	40-40-10 mfd, 450-v electrolytic (Mallory FP 376.8)
C9	10000/√ Zvc mmfd
C10	40-40 mfd, 450-v electrolytic (Mallory FP-238)
C11	15 mfd, 1000-v oil
C12	0.5 mfd, 200-v molded paper tubular

(All resistors 1/2 watt 10% unless otherwise indicated)

R1	470 k
R2	10 K
R3	100
R4	910, 5%
R5	270 K, 2 w
R6	820K
R7	470 K
R8	10 K
R9	1 meg
R10	1500 w
R11, R12	10 K, 2w matched
R13, R14	100 K matched
R15, R16	100
R17, R18	100
R19	4700 2w
R20	15
R21	820
R22	470
R23	5100, 2w, 5% } see text
R24	4700, 2w
R25	100 K
R26	330 K
R27	1.8 meg
R28	33 K 1w
R29	68 K 1w
R30	10 K 10w
R31, R32	15 K 20 w
R33	100 K 1w
R34	550 √ Zvc

Miscellaneous

2	Millen #36002 ceramic plate caps
1	SPST toggle switch
1	extractor fuse holder
1	3AG, 3-amp fuse
2	Cinch #2008 terminal strips
2	Cinch #2007 terminal strips
2	Cinch #2006 terminal strips
3	Cinch #2005 terminal strips
3	Cambridge Thermionics #X2006 (or equivalent) insulated terminals
1	2 x 7 x 13" aluminum chassis
2	7-pin miniature tube sockets
2	9-pin miniature tube sockets
4	octal tube sockets
2	Cinch #2C7 FP capacitor sockets
1	Eby #56-2 (or equivalent) screw terminal strip
1	Eby #56-4 (or equivalent) screw terminal strip
	hook-up wire, rosin solder, misc. hardware

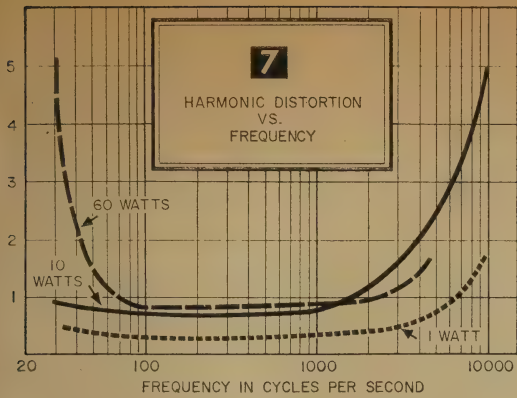
cause the high heat conductivity of the metal makes the whole chassis surface available as a radiator. While heat dissipation of this amplifier is considerably below that of most others in its power class, its compact design does keep the dissipation per unit volume fairly high. For this reason, The Leasebreaker should never be enclosed in a small space.

Testing. With the 5R4 removed, a dummy load connected and the feedback loop open, the first job is to adjust the bias. Select 4700 and 5100 ohm resistors so that the bias is minus-50 volts. If necessary, other resistors can be shunted across one or the other for vernier adjustment.

Next, if a milliammeter is available, check the current drawn by the OB2, which should be around 10 mls. Variation of R21, an 820-ohm resistor, can raise or lower this as desired.

To set the screen voltage, replace the 5R4 and turn on the power. The high voltage at the 15-mfd capacitor should be around 750 v. Now check screen voltage. If it is not in the range of 200-215 v, shunt one of the resistors in the control voltage divider. Shunting R27 reduces the screen voltage; shunting R25 increases it. Use high values for the first try; the circuit is quite sensitive.

When screen voltage is set, the various other voltages can be checked. A VTVM should be used to measure the 6AU6 plate and screen. If results are



satisfactory, feed a 400-cycle test signal into the input and turn up its level. The amplifier should deliver 75 watts (33 v rms into a 15-ohm load) just at the clipping level as seen on a scope.

As regards the feedback loop, if the output transformer primary leads have been connected as indicated, and if the manufacturer is uniform in attaching leads to the windings, the feedback should be negative. With the oscillator providing the 400-cycle test signal set for low output, watch the output signal on a scope while touching a 22K resistor across the feedback terminals. If the output decreases, the feedback is indeed negative and the proper feedback resistor may be installed. If the output increases, reverse the output transformer primary leads and try again. It is wise to use the 22K resistor for the initial test so that if the feedback happens to be positive, the amplifier will be spared the burden of violent oscillation. Resistor R34 and capacitor C9 are chosen according to voice coil impedance (see Materials List); but explicitly:

Voice Coil Impedance	R34	C9
16 ohms	150 ohms	2500 mmf
8 ohms	200 ohms	3600 mmf
4 ohms	270 ohms	5000 mmf

With the feedback loop closed, a frequency response run at a level of about 1-v output may be made. The amplifier should be down about 0.5 db at 20 and 20,000 cycles, and should fall continuously outside of those points as discussed previously.

Note particularly—this amplifier is intended only to be flat to 20 kc, not to 100 kc! People accustomed to 100-kc bandwidth and a fancy square wave response will be disappointed by this—but our aim was a stable amplifier. This type of response is the price of using a cheap output transformer. Similarly at the low end—but it should be noted that smoothly falling response below 20 cycles is beneficial in attenuating rumble from turntables.

In checking the power output, the amplifier

should deliver 65 watts at 30 cycles and 75 watts at 40 cycles and above, at the clipping level and just before noticeable flattening appears on the scope. Full power should not be run continuously above 5000 cycles since the network across the output transformer primary begins to absorb power and the 4700 ohm resistor R19 will "head west" in a big hurry.

Instead, make quick checks at 10 and 15 kc by turning up the oscillator for no more than a second or two, reading the meter and immediately turning down the oscillator. Power should be 65 watts at 10 kc and 40 watts at 15 kilocycles.

This drooping power response does no harm to program material where the vast bulk of power lies below 1000 cycles, and the amplifier will break up at low frequencies long before the point where high-frequency power will endanger the 4700-ohm resistor.

The Leasebreaker may be used with any standard pre-amplifier, although we don't recommend that the preamp power be drawn from the amplifier, as it is very difficult to provide sufficient plate supply decoupling to make the system really stable at sub-audible frequencies. Either the preamp should be self-powered, or a separate power supply should be built for it. Voltage gain from input to 16-ohm output is 20, hence 1 v in will produce 25 watts—a sensitivity of the same order as any usual home music amplifier.

Internal impedance as measured at the 16-ohm output tap is 1.3 ohms, resulting in a damping factor of 12, which is adequate for restricting speaker hangover. Total hum and noise output with the input shorted is less than 5 millivolts at the 16-ohm tap, or better than 75 db below 60 watts output. This is predominantly power-supply ripple due to imbalance in the output tubes, but 5 millivolts of hum is so low as to be barely audible a foot from a good speaker.

Harmonic distortion was measured as a function of frequency for several power levels and the results were about what might be expected.

The low-level distortion is higher than that in units of the Williamson type, but not seriously, since any reasonable amplifier distortion pales into insignificance compared to that contributed by even the best of speakers. The curves (Fig. 7) show the usual rise at the ends of the range, the low end curve at 60 watts being due to the onset of core saturation. The high end rise, however, is only of academic interest since the 10- and 60-watt power levels will never be reached by program material at frequencies above 1000 cycles.

If you haven't seen curves like Fig. 7 before, be advised that the usual practice of using only mid-band frequencies in distortion ratings tends to make an amplifier look better than it really is.

Radio Tuner for Child's Phono

Your child can have his phono and radio, too—
all in one package

By HOMER L. DAVIDSON



Enjoyment is doubled with the addition of a radio tuner to a child's record player.

THIS tiny RF tuner can easily be attached to the young fry's record player, converting it to a radio receiver. The tuner consists of a tuned input stage with a small, variable capacitor. The separated signal is then rectified to audio power and amplified by a small transistor. From here the signal is applied to the pick-up arm and then amplified by the phono-amplifier itself.

Circuit. The RF signal is picked up from a small lead that should be clipped to an outside antenna for best results. For local stations, a bed spring or metal window frame will pick up enough signal to drive the loudspeaker. A small ferrite coil with a tunable slug and a variable capacitor separates the stations. The slug can be tuned in or out to separate several local stations if one (or more) seems to bother the desired station.

A fixed crystal diode detects the audio signal, which is then amplified by the 2N107 transistor. The transistor was added here to help amplify the weak detected signal, as some of the cheaper record players have only one amplifying tube. Since all phonographs have their own volume control, there was no need to place one upon the small tuner. Also, most record players have a tone control, but most radios do not.

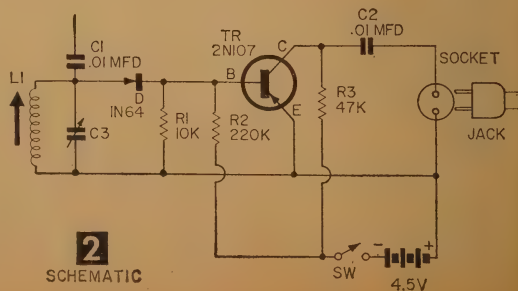
A small, fixed capacitor couples the audio signal to the phono pickup arm. It is best to first remove the record player arm from the phonograph before wiring up the male jack.

Be careful not to damage the crystal cartridge by rough handling. Generally, a small pin or swivel screw holds the pickup arm to the horizontal swivel bracket. Remove this, and the arm can be taken off. Be sure to unsolder the two small wires that go from the amplifier to the pickup arm.

Phono Arm Repair. Drill a $\frac{1}{32}$ -in. hole in the middle of the phono pickup arm. This hole should not be drilled too far back on the arm because of the sharp angle in lifting the arm before the male plug is inserted into the radio tuner. Two small, flexible wires are soldered to each terminal and brought out so they can be soldered to the crystal cartridge connection. Do not solder these connections until they are pulled off the cartridge. Heat will sometimes damage the crystal cartridge. Place the connections back on the cartridge, and the arm is ready to go. Now remount the phono arm

in its original position. All that you're doing is making a simple way to plug the phono amplifier into the radio tuner box.

Battery and Cabinet Construction. If your case is large enough, use two penlite cells in series or an Eveready 4.05 v. (E133) or an RCA 4.5 v. battery. Since my plastic case was only $1\frac{1}{4} \times 1\frac{1}{2} \times 2\frac{1}{4}$ in., I had to devise a smaller battery: Three small button mercury cells were used to furnish 4.5 v. of collector voltage. These batteries are the size of small buttons, and being so small, must be mounted in such a way that good contact is made. Cut the closed end from the zinc casing of a small penlite cell to a length of $\frac{3}{4}$ in. Clean out all loose carbon and residue from the inside of the cell. Cut a piece of thin cardboard long enough to just meet the ends when inserted inside of the penlite zinc case. Drop a small



MATERIALS LIST—CHILD'S PHONO-RADIO

Desig.	Description
C1, C2	.01 mfd flat ceramic capacitors
D	1N64 xtal fixed diode
C3	365 mfd miniature variable capacitor (Lafayette MS-274)
L	ferrite coil (Lafayette MS-11)
R1	10,000 ohm resistor, 1/2 watt
R2	220,000 ohm resistor, 1/2 watt
R3	47,000 ohm resistor, 1/2 watt
SW	SPST switch (Lafayette VC-42 or equivalent to fit case—such as Cutler-Hammer's type 8098-K3, Allied 34B510)
TR	GE 2N107
Batt	4.5 v (see text)
plug	miniature plug (Lafayette MS-284)
jack	miniature jack (Lafayette MS-283)
	plastic cabinet (Lafayette MS-298 or other)

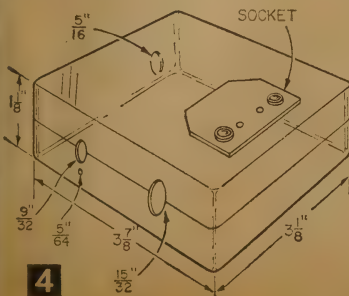
shiny split lock washer into the bottom of the case, and insert the first button battery. Insert all three batteries, observing correct polarity. The batteries will fit snugly, and should be pressed together as tightly as possible.

The center contact connector and mounting screw are bolted to a small fiber washer (see Figure 5). Use the smallest bolt and nut combination here, so that they do not touch the crimped sides.

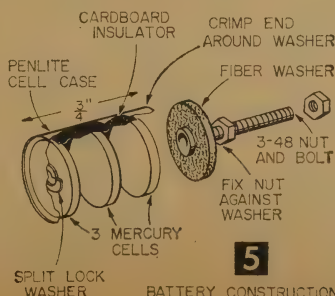
Place the washer and bolt into the top of the battery. While pressing down on the bolt, crimp the edges of the zinc case over the top of the insulated washer. Be very careful not to touch the center post to the crimped edge, as this will short out the newly constructed battery. The little battery is ready to mount with its own mounting screw.

The plastic case I used was the container from an Argonne (Lafayette) interstage transformer. Any plastic box at least 1 1/8 in. high, but not too high to fit under the pickup arm can be used. If no other box is available, you will have to use Lafayette's MS-298 (1 1/8 x 3 3/8 x 3 3/8 in.). Drill holes for the ferrite coil assembly, variable capacitor and on-off switch. Mount the female plug atop the case. You can use the tip of the soldering iron to make the larger holes in the plastic, as long as you don't hold the iron to the case too long.

After all the holes are drilled, the large components are mounted. First, the capacitor and switch are mounted, then the battery.

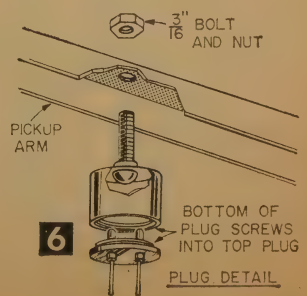


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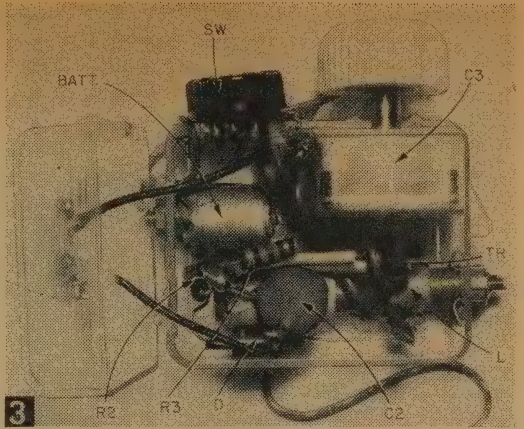
5

BATTERY CONSTRUCTION



6

PLUG DETAIL



Parts layout of the RF tuner in a tiny 1 1/4 x 1 1/2 x 2 1/2 in. box. Any case you have available may be used (see text).

Before mounting the ferrite coil, solder the diode and resistor into place, and solder two small pigtailed to each side. This will save a lot of close soldering down inside the case. The small resistor, capacitors and transistor can be soldered as they are mounted. While the lid is open, solder two small flexible leads to the female plug and to its corresponding circuit. The unit can now be wired. Be sure the battery polarity is observed.

The unit is placed directly under the pickup arm and plugged into it. Turn the record player on, and let the tube heat up a few seconds. Hook an outside antenna or long wire to the small antenna wire. Then, turn on the radio-tuner. If there is hum, reverse the ac plug on the phono.

Surprising results were obtained with the small radio-tuner on local and distant stations. The batteries should last a long time, as only 1/5th of a milliamperes is pulled from them.

The small plastic case can now be bolted to the phonograph mounting board. Always turn the batteries off when only the record player is being used to play records. The pickup arm mounting holder can be removed or re-mounted closer toward the turntable if so desired.

ELECTRON TUBE ANAGRAM

Although transistors are rapidly replacing electron tubes in many applications, tubes still perform jobs that transistors cannot handle. This anagram puzzle pertains entirely to electron tube terminology.

Can you correctly fill in all the empty blocks with the correct words, letters, symbols and abbreviations? When you have the blocks all filled, check your solution with the correct one on page 152.

By JOHN A. COMSTOCK

ACROSS:

- 1) Seven-element electron tube.
- 4) A ——— cutoff tube is one in which the control grid spirals are uniformly spaced.
- 7) A gain compensating vacuum tube circuit (abbr.).
- 10) A straight line drawing across a series of plate current-plate voltage curves.
- 11) A ——— tron is a five-element tube having two plates.
- 15) Output power (abbr.).
- 16) Target (abbr.).
- 18) A vacuum tube circuit that sets up and maintains sustained oscillations. (abbr.).
- 19) A tube in which the electron stream is concentrated or "focused" for greater amplification.
- 20) To reduce this, some tubes have a center-tapped filament.
- 21) Unit of current usually applied to electron tubes. (abbr.).
- 22) A floating grid.
- 24) A cathode-ray tuning indicator tube is sometimes called a "magic ———."
- 25) A tube noise effect that limits high amplification.
- 27) Negative potential applied to a control grid.
- 28) Interelectrode capacitance between grid and plate (letters symbol).
- 30) Part of a CRT tube.
- 32) ——— uration is the point reached when current is

maximum obtainable by increasing plate voltage or cathode temperature.

- 33) Particles heavier than electrons that are harmful to a CRT tube's screen.
- 35) A variable resistor used in many vacuum tube circuits (abbr.).
- 37) An electron tube's signal input element.
- 41) Electron flow effect in an electron tube.
- 44) The "at-rest" potential applied to tube elements.
- 46) Unit of conductance.
- 48) A cathode that emits electrons when struck by light rays.
- 49) Heater tap for pilot lamp (letters symbol).
- 51) ——— = $R_p \times G_m$ (supply missing term).

- 52) The alkali earth metal introduced into a vacuum tube to remove residual gas.

53) $u = \frac{dEp}{?}$ (supply missing term).

DOWN:

- 1) A ——— -wave rectifier has only one plate.
- 2) Electron receiving element.
- 3) $u = \frac{?}{dEg}$ (supply missing term).
- 5) A ——— ode tube is one having a total of six elements.
- 6) The ratio of a small change in plate voltage divided by a small change in plate current (letters symbol).
- 7) A particular vacuum tube element.
- 8) A tube envelope designation (abbr.).

- 9) Electron tube emitting element (abbr.).

- 12) Plate potential (letters symbol).

- 13) The name of the grid that was added to triodes in 1929.

14) ——— = $\frac{dIp}{dEg}$ (supply missing term).

- 17) The name of Lee de Forest's triode tube.

- 19) The ones used on most octal tubes are of Bakelite.

- 23) A unilateral vacuum tube circuit (abbr.).

- 26) Made to determine whether or not a tube is good.

- 29) Tube connectors.

- 31) Plate capacitance letters symbol.

- 34) A tube's second grid (abbr.).

- 36) A tube base having eight equally spaced pins and a central aligning key.

- 38) A ——— cutoff tube is sometimes called a "supercontrol" tube.

- 39) The vacuum tube invented by Fleming.

- 40) A tube that doesn't contain gas (abbr.).

- 41) C-bias voltage (letters symbol).

- 42) Cathode current (letters symbol).

- 43) An inert gas used in some gaseous electron tubes.

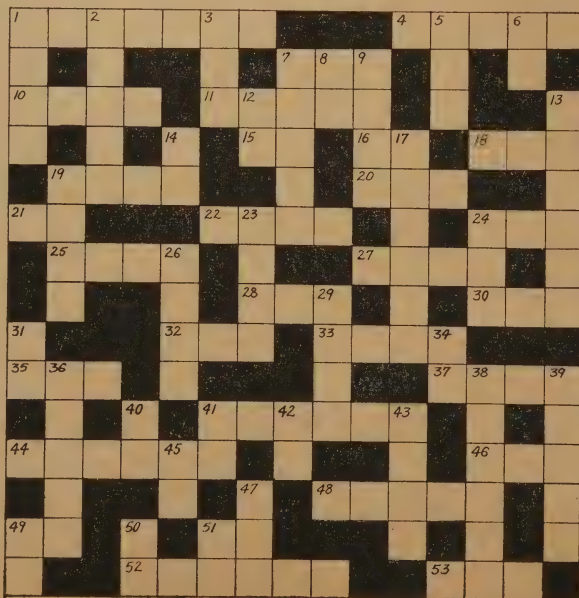
- 45) Plate current flow (letters symbol).

- 47) A remote ——— off tube is a variable Mu tube.

- 48) Heater mid-tap (letters symbol).

- 50) Grid conductance (letters symbol).

- 51) Shell designation: metal tube (letters symbol).



What to Listen for on Short Wave

Fall & Winter 1960

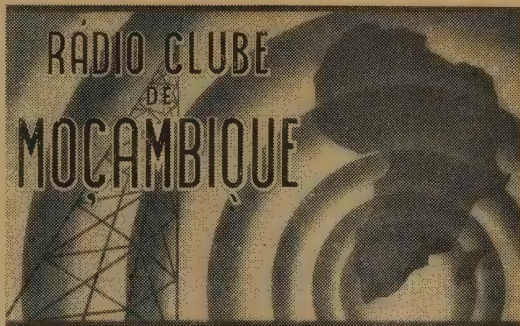
By C. M. STANBURY II

WINTER on short wave presents a paradox, an important one for the listener. As you probably know, ionization (caused when ultra violet radiation from the sun passes through the atmosphere) is responsible for both the reflection of radio waves back to earth (essential for distant reception) and the absorption (weakening) of radio waves, especially frequencies below 7000 kc. Also commonly known, during winter with shorter days and rays from the sun received more obliquely, ionization is reduced, signals are stronger, and reflection from the ionosphere should decrease at higher frequencies. The latter is *not* true. Frequencies above 15 mc are normally reflected by the F2 layer, the uppermost portion of the ionosphere, and reflection in this region is actually improved as the earth approaches its winter solstice, the point in the earth's orbit when it is closest to the sun. Why? We don't know and neither does anybody else. Some researchers have linked this phenomenon with temperature but the theory appears to have holes in it.

In any case, the result is a broader range of usable wavelengths with both higher and lower frequencies open. However, there is a second factor to consider, sunspots. Ionization, reflection and absorption all vary directly with the number of "spots" on the sun and right now we have a dropping count. Result, the higher frequencies will be slightly poorer than last winter, but low frequencies will be better. Add to this little or no static on downstair channels and you have prospects for an excellent short wave season.

We should say excellent for the serious listener. If you read the article *Tune In On The World* in Radio-TV Experimenter #565, you may recall that I suggested that one way to know other countries was to listen in on local broadcasts intended only for the area from which they originate. This is usually not easy. But many countries do use the lower short wave frequencies for such purposes, particularly in the tropics and in such a country as Russia where one transmitter must cover a good many square miles of sparsely populated territory. Of course you'll still face a language barrier. Which leaves the music. However this is sometimes more revealing than words particularly when the words are propaganda while the music is not too polished folk music.

With reception of local broadcasters as



Verification card from Radio Clube de Mocambique, a semilocal (regional) broadcaster heard throughout the World on 11760 kc. However, as indicated on reverse side of card, this QSL is for reception on the Broadcast Band during the peak period for lower frequencies, 1953-55. Winter 1960 will represent the very early stages of another such period.

МОСКОВСКОЕ РАДИО

Адрес: Москва, Радио

Тел. №...

Moscow, USSR
July 24, 1958

C.M. Stanbury II
Box 218
Crystal Beach, Ontario,
CANADA

Dear Mr. Stanbury,

Thank you very much for your reception reports on our Sputniks.

Enclosed please find a verification card as well as a Sputnik badge, as a souvenir.

Under separate cover, we are sending you a copy of the magazine "Soviet Union" in which you can find the information about Sputnik III.

Hoping to hear from you again,

Sincerely yours,

E. Stepanova
(Eugenia Stepanova)

RADIO MOSCOW
North American Service

Verification letter for Sputniks I and III (no longer broadcasting) heard at 20.005 mc.

the goal, frequencies below 7000 kc. become all important and a dropping sunspot count can be nothing but good news. How far has it dropped? Well, the count has a long way to go but even in April two stations in the 120 meter band, H13C (2440 kc, La Romana, Dominican Republic) and Radio Martinique could be heard throughout the eastern United States.

International Broadcasting. If you're new to short wave listening, or you just plain want to listen and keep DXing down to minimum, then the International Bands, 31 through 13

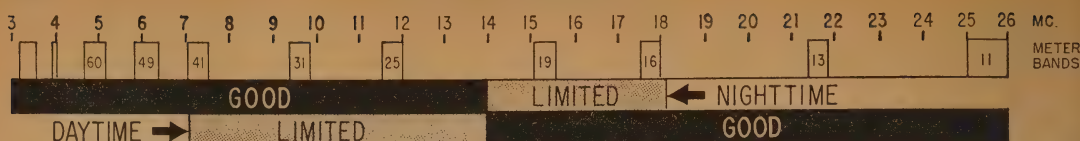


TABLE A: BEST BANDS BY NIGHT AND DAY

meters (see Table A) will interest you most. That boost in the F2 layer will certainly make things better than in the summer. But reception will be slightly poorer than last winter.

The 13 meter band will be open many days to all parts of the world with north and south paths having an edge. Europe will be best during daylight hours on the 19 and 16 meter bands and then at night on the 31 and 25 meter bands. Africa will follow a roughly similar pattern. The 19 and 16 meter bands may remain open the first few hours of darkness with both Europe and Asia received. Such a path will occasionally hold up most of the night with the 25 meter band providing an alternate band for evening reception of the Orient. During the hours after midnight both 25 and 31 meters will produce signals

from Asia and the Pacific. Technically this would be the best time for such listening but most broadcasts to North America are made during the more convenient evening hours: Thus 19, 25 and 31 become bands for all parts of the world with the latter pair most dependable.

Possibly you gathered from these predictions the increasing importance of 31 meters. As the sunspot count continues to drop it will become almost irreplaceable in international broadcasting. Unfortunately, it may have to be replaced. Crowding on this band is fast reaching an intolerable saturation, even for the comparatively hardy SWL. As an example, listen to the 15 kc spread between 9585 and 9600. During the evening we have no less than 5 transmitters in this tiny portion of the radio spectrum, Radio Canada

TABLE B—GOOD SHORTWAVE LISTENING

COUNTRY	FREQUENCY IN KC/S	TIME* (EST)	STATION AND DETAILS
WINDWARD ISLANDS	3365, 15085 5010	1600-2115 1600-1730	West Indies Broadcast Service. Here we have the happy circumstance of a semi-local broadcaster using an international band (after 7:30). This one intended for the Caribbean Federation (British West Indies) features a variety of local programs which are a blend of British, Caribbean and American cultures.
MOZAMBIQUE	11760	2230 until fadeout	Another semi-local program in international territory. This will give you a good idea what the English and Afrikaans (Dutch) of Central and South Africa consider entertainment. Programs do not include news. Reception will be best on the Pacific Coast.
CONGO REPUBLIC	11725	2100-2145	Radio Brazzaville. African news from a French point of view. Also French music and French lessons.
ISRAEL	9008 (or 9725)	1530-1600	Kol Israel (or Kol Zion), Zionist picture of Near East news, limited amount of folk music.
SWITZERLAND	11865, 9535 and 6165	2030-2215 and 2315-2400	Swiss Broadcasting Corporation. Neutral international news (government) followed by democratic West European viewpoint from Swiss newspapers. Has sunspot report once a month.
NETHERLANDS	15220 (or 16 meters) 11755 and 9590 (or 9715)	1615-1705 2130-2210	Radio Nederland. Most interesting features here are international news and topical talks.
GREAT BRITAIN	Several frequencies throughout the bands	1600-2200	General Overseas Service, British Broadcasting Corporation. Good example of conservative British programming and thought.
JAPAN	17855, 15235 and 11705	1930-2015	Radio Japan. Features on Japan and a limited amount of Japanese folk music.
AUSTRALIA	11710 11810	0714-0845 1014-1145	Radio Australia. Most important feature here is news from the fifth continent. Remainder of program is primarily entertainment.
ARGENTINA	9690 (or 15345)	2200-2300 and 0000-0100	R.A.E. Compare the polished Argentine music with the more interesting Latin varieties easily heard on 49 and 60 meters.

* Time is given on the 24-hour clock. 1200 is 12 noon, 1300 is 1 pm, 2400 is midnight, and so on. In other words, for times past noon subtract 1200 to get Eastern Standard Time.

† Frequencies listed in brackets are alternate possibilities. If you fail to hear a program on the channels listed first, try these.

da (CKLP), Radio Nederland, Radio Cultura de Bahia (ZYN 29), Radio Moscow, Radio Republik Indonesia (YDF6) and the British Broadcasting Corp. (GRY). Of this group, ZYN29 and YD F6 would be the newer, and it is this continuous stream of new tropical stations coming on the band which is mainly responsible for such overloaded channels. Of course they have as much right here as any other country.

The International Telecommunications Union is taking steps to alleviate this situation but the ITU does not have enforcement powers.

If the malady is not cured, or at least arrested, broadcasters will either have to concentrate on 25 meters, in which case that band might soon look like 31, or switch their programs to less advantageous afternoon periods.

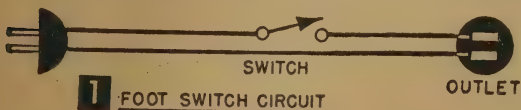
Handy Foot Switch

A FOOT switch on your table saw or drill press may limit the damage that can occur in the event of an accident. A foot switch comes in handy at the telephone to mute a blaring radio or near your easy chair to kill TV commercials. There are uses for the foot switch in the kitchen, too.

There are several types of switches that may be employed for foot switch duty. Several commercial foot switches, some of them in the form of a mat, are available. But these switches are rather expensive. You can make your own from inexpensive basic switch units, enabling you to choose according to your power and function requirements.

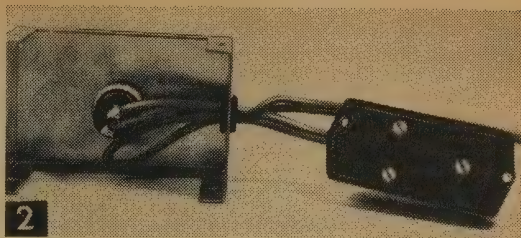
You'll want either a positive action switch, which remains on once you switch it, or a momentary contact switch, which is only on when you hold it on. A positive action switch may be desirable for a foot switch for your wife's electric mixer; a momentary contact switch is desirable for power tools since the natural tendency in an emergency is to release the switch.

Power handling ability is important too. Switches are rated by volts and amps rather than by watts. To determine the amperage of an appliance, divide the wattage of the device by the voltage, usually about 120. Thus, the switch required for a 600 watt appliance must have at least a 5 amp. rating at 120 v. Another point to remember is that switches

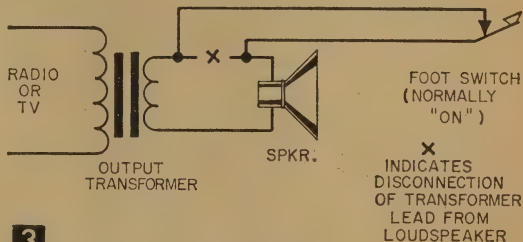


are rated for resistive loads. Devices which involve coils or capacitors (for example, anything containing a motor) usually demand currents in excess of the current computed by this method. It's usually desirable to use a switch that can handle more current than the controlled appliance requires.

The circuit for a practical foot switch is shown in Figure 1. The SPST switch is connected in one side of the ac line. A plug is provided for easy connection to any ac outlet. A receptacle is provided so that the switch may be used to control any or several appliances. The back view of the unit is shown in Figure 2. The switch is housed in a small metal box. A 1/2-in. hole drilled in or near the center of the front side of the box is required for the switch. A 3/8-in. hole is needed in the end of the box for the line cord. Insert a rubber grommet in the end hole. Double a convenience outlet extension cord on itself near the outlet end, and push the doubled end



Chassis view of switch before attaching back.



Speaker muting foot switch. X indicates disconnection of transformer lead from loudspeaker.

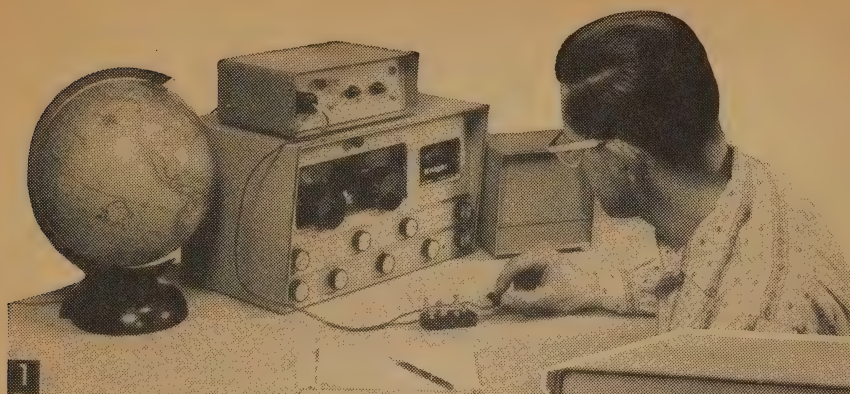
through the grommet into the metal box. Mount the switch, separate the parallel conductors, and connect them and solder. Wrap tape around the cord next to the grommet on the inside of the metal box as a strain relief. The box may be fastened to the floor with four small brackets attached to the sides. The connection to the line and to a specific power tool can be made permanent, too. If current exceeds 5 amps, a permanent installation is desirable.

Several switches are listed in the materials list. Pick the one that suits your function and current requirements. Note that you can obtain a normally on switch which will turn off when you place your foot on it. This type of switch placed near the phone with radio or TV set connected to the outlet is handy for turning either of these blaring contraptions off during a phone conversation. An alternate scheme which utilizes a normally on switch to mute the audio on a TV set from your easy chair during commercials is shown in Figure 3. In this case the switch is connected in the speaker coil circuit and does not control high voltages or currents.—FRANK WOODS, JR.

MATERIALS LIST—FOOT SWITCH

No.	Req.	Description
1	switch, either a momentary contact type, such as 1/2 amp, normally off (Grayhill 4001) or 1/2 amp, normally on (Grayhill 4002) or 10 amp, normally off (Grayhill 2201) or 10 amp, normally on (Grayhill 2202) or a positive contact type, 4 amp, push on-push off (Carling 110-SP).	
1	3/4x2 1/8x1 3/8" metal box (Bud CU-2101)	
1	convenience outlet extension (electrical or variety store)	

Transmitter for the Novice



Novice transmitter shown here atop a Knight-Kit receiver, is powered by an external power supply, permitting fixed or mobile use. Inset shows closeup of transmitter face.

By ALICE ROLF, KN5SEL

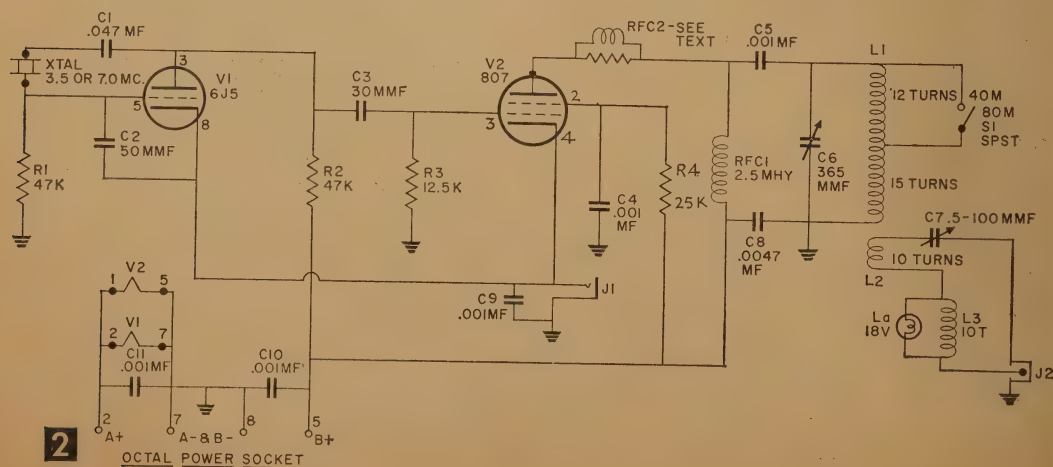
HERE'S a compact 75-watt transmitter that even a Novice YL can build. In fact, a Novice XYL did build it after her husband drilled the panel and took over as babysitter. The rig puts out a good signal on 40 and 80 meters, featuring bandswitching, and can be used either at home or in the car with a suitable power supply.

The two-tube circuit shown in Fig. 2 fits into a U.S. Army 30 cal. ammunition tin, available at surplus stores. The $3\frac{1}{4} \times 6\frac{3}{4} \times 10\frac{1}{4}$ -in. cabinet is modern enough to enhance any shack, and small enough to fit comfortably under the dash of even a foreign car. If an ammo tin is not available, the circuit can easily be enclosed in a small commercial

metal cabinet available from radio supply houses.

The transmitter is built in a $5\frac{3}{4} \times 9\frac{3}{4}$ -in. hardboard chassis, with a $3\frac{1}{4} \times 10\frac{1}{8}$ -in. metal panel bracket-attached. Use two brackets of any convenient size and sturdy enough to support the panel, which extends about $\frac{1}{4}$ -in. below the Masonite.

Drill all the panel holes before fastening the panel to the chassis. The power socket, key jack, band switch, tuning capacitors, dial light jewel, and antenna jack mount on this panel, the remainder of the components mount on the chassis. The 807 socket mounts on an aluminum bracket $1\frac{3}{4}$ -in. high at the right-rear of the chassis, leaving plenty of



MATERIALS LIST—NOVICE TRANSMITTER

Desig.	Description
C1	.047 mfd 200 wv tubular
C2	50 mmfd mica
C3	30 mmfd mica
C4	.001 mfd 1 kv, disc
C5	.001 mfd 1.5 kv tubular
C6	365 mmfd single gang broadcast type variable (Philmore)
C7	5-100 mmfd variable (Bud MC 1873)
C8	.0047 mfd 1 kv, disc
C9	.001 mfd, 1 kv, disc
C10	.001 mfd, 1 kv disc
C11	.001 mfd, 1 kv, disc
J1	phono jack, single circuit (Mallory)
J2	miniature coax jack
L1	27 turns #22 enameled close wound on 1" form, tapped 15 turns from bottom
L2	10 turns #22 enameled close wound over top half of L1
L3	10 turns #22 or #18 enameled close wound 1/2" form
La	#1455 18-V pilot lamp
RFC 1	2.5 mhy, 100 ma RF choke (National)
RFC 2	parasitic choke or 5 turns #22 or #18 enameled wound on 50-ohm, 1-watt resistor

Desig.	Description
R1	47,000 ohm, 1/2 watt
R2	47,000 ohm, 1 watt
R3	12,500 ohm, 10 watt
R4	25,000 ohm, 10 watt
S1	SPST toggle switch (Arrow-Hart & Hegmen #20994NV)
V1	6J5 vacuum tube
V2	807 vacuum tube
Xtal	80- or 40-meter crystal—for Novice band 3750 KC to 3800 KC (80 M) or 7150 to 7200 KC (40 M)
20	6-32 x 1/4" machine screws and nuts
10	#8 terminal lugs
2	single lug terminal strips
1	dial lamp jewel
1	ceramic octal socket (6J5)
1	5-prong socket (807)
2	octal wafer sockets (xtal and power sockets)
1	octal plug (for power cable)
1 pc	hardboard 3/4 x 5 x 10" (chassis)
1 pc	1/16" steel or aluminum 3/4 x 10" (panel)
6 ft	4-wire rubber insulated cable (insulated for 1000 volts)

room for the 807. Place the tank coil between the panel and the 807 (Fig. 3).

Mount the socket for the 6J5 on the left side of the chassis. Clip the mounting saddle of the socket away with a pair of snips and drill holes in the hardboard so that the socket solder lugs extend through the chassis. These holes are aligned by first drilling the key hole for the key pin of the 6J5. Put a drop of finger-nail polish on the pins of the 6J5 and press it against the chassis with the key in the drilled hole. The polish will mark hole locations. After drilling, press the lugs into the holes until the socket is flush with the chassis. Bend the lugs back so that they lock the socket in place.

Mount the remainder of the components on #8 terminal lugs which are fastened to the hardboard by 6-32 x 1/4-in. machine screws—except for the two connections of RFC1. This choke is mounted on two single lug terminal strips in order to isolate the high RF potentials from the metal cabinet. Parts layout is not critical, but should be similar to that shown in Fig. 3.

Extend a length of #12 wire across the front of the chassis and ground it to the panel for a ground bus bar. Connect the 807 mounting bracket to this bar. All ground leads should be connected to this bus, the panel, or the 807 mounting bracket.

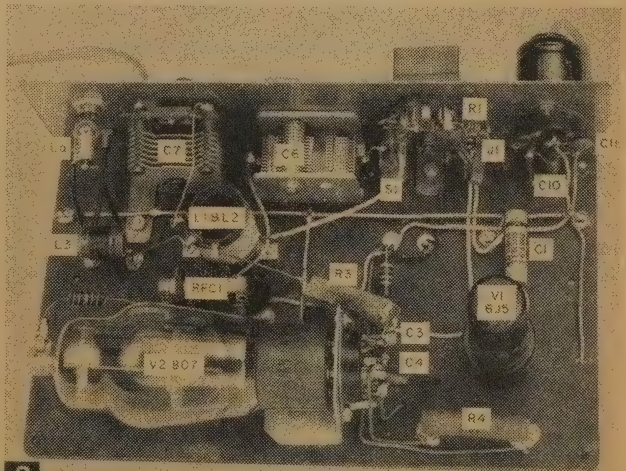
Connect the leads to the 6J5 socket and bring them to the top of the chassis through holes drilled around the tube socket. Indicator lamp terminals must not be grounded; they are supported by two pieces of solid wire.

Coils L1 and L2 are #22 enameled copper wire wound in a 1-in. dia. form. This form can be a commercial unit with mounting brackets, or a cardboard or plastic tube 1 1/2-

in. long. L1 is wound with the connection for C5 at the bottom of the form, nearest the chassis, and the ground connection at the top.

The tap for the bandswitch is placed 12 turns from the bottom of the coil. Twist the wire into a loop for the bandswitch connection and wind the other 15 turns. Coil L2 is wound over the top of L1 between the bandswitch tap connection and the top of the form. Wind it over a layer of Scotch tape with the connection to C7 at the top of the form.

Coil L3 consists of 10 turns of #22 or #18



Components are mounted on terminal lugs, the 807 socket is mounted on an aluminum bracket and the 6J5 socket mounts similar to sockets in printed circuitry. A wafer-type octal socket is used for the crystal.

enameled wire close-wound on a 1/2-in. form; RFC 2 can either be a commercial parasitic choke of five turns of #22 or #18 enameled wire wound on a 47 ohm, 1-watt resistor. For the antenna jack (J2 in Fig. 2) use a miniature connector jack of a coax type.

Amplification
Amplification

Amplification

Amplification

The simple "control-impedance" principle explains this vital, modern process

By C. F. ROCKEY

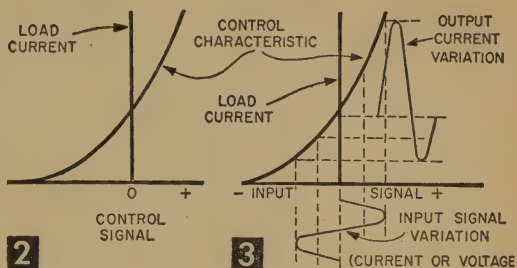
NOT all amplification is electronic. Fundamentally, amplification is any process in which a great amount of power is controlled by a lesser amount. The throttle valve of an automobile, through which the full power of a several hundred *hp* engine is controlled by the touch of a toe, is a crude amplification system.

Because electronic amplification first found wide use in radio, however, this process is firmly linked with electronics in most people's minds. Although technicians frequently speak of "current amplification" or "voltage gain," the most fundamental form of amplification is *power amplification*:

$$\text{Power Amplification} = \frac{\text{Power Output}}{\text{Power Input}}$$

Power Output refers to the large amount of power being controlled; Power Input, the much smaller amount of power that does the controlling. Often, in industrial usage, the power input may be called the "control signal." Both quantities in the fraction may be in ergs per second, joules per second, kilocalories per second, horsepower, or other power units, but *watts* or *kilowatts* are most widely used in electrical systems. Since both numerator and denominator must be expressed in the same units, it is seen that power amplification is a dimensionless, "pure ratio," without units in itself.

Power amplification is considered most fundamental here because neither current nor voltage amplification can occur without the simultaneous occurrence of power amplification. This is the case in the vacuum tube, the transistor, the magnetic amplifier, and all other true amplifying devices used today. For instance, although a transformer can readily step up electrical voltage, it does so at the expense of a proportionately decreased amount of available current. Therefore the power available for exerting any useful func-



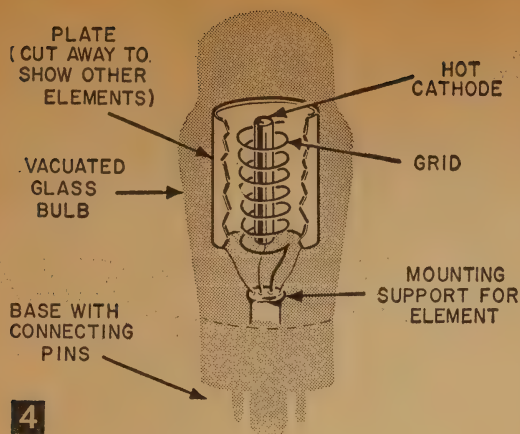
tion has not been increased, and in practice it is usually decreased slightly. Thus a transformer, in itself, is not an amplifier.

The basis of all amplification is control. No amplifier generates power, it merely makes it possible for a small amount to control a large amount. Thus the essence of an amplifier is what engineers call a *control impedance*, a device whose ability to pass electric current is at the direct command of a small control signal—a relatively small electrical current or voltage. In Fig. 1 the input control signal is shown as an alternating voltage generator and the supply voltage as a direct-current source, but this is by no means always the case. Amplifiers may be made to work with either *ac* or *dc* signals or supply sources. All that is needed fundamentally is an input or control signal, a control impedance, a relatively large power source, and a load. The *load* (represented in Fig. 1 as a resistor) may be an electric motor, solenoid coil, transformer, lighting circuit, loudspeaker, radio transmitting antenna, heating coil, or any other device capable of applying electrical power to a useful function.

The high-energy source in the output circuit of an amplifier causes a steady current to flow through the control impedance and load, normally, even when no control signal exists at the input terminals. When the input control signal, either voltage or current as the case may be, increases, it decreases the opposition which the control impedance offers to the flow of current from the high-energy source, and more current flows through it and the load. The load then consumes more power, normally, in proportion to the input signal. If the control signal decreases to zero, the current supplied to the load decreases to its resting value.

Now, should the control signal reverse in





4

polarity, it will increase the opposition to current flow in the load circuit, causing the load to consume less than the resting current value. The control signal at the input terminals directly regulates the internal opposition to current flow by the control impedance. Since the power supplied to the load is the product of the current flowing through it times the voltage across it, changing its current supply directly affects the power consumed by the load. And because the load current is a function of the input control signal's intensity and polarity, power amplification is the result.

The control characteristic is a graph (or curve, as engineers call it) relating output or load current to input signal magnitude. Although the control characteristic of tubes, transistors, or magnetic amplifiers may be quite irregular in practice, it is represented in Fig. 2 as a smooth, gradually curving line. The output current magnitude is found on the vertical, the control signal magnitude on the horizontal line.

To show how an engineer uses the control characteristic to predict the behavior of a control impedance as an amplifying device, a hypothetical alternating-control signal is projected in Fig. 3 upon the characteristic curve's horizontal axis.

Note in Fig. 3 that there is a specific value of load current for each instantaneous value of control signal magnitude. Thus the output or load current is under constant, direct control by the input signal. And, since the output or load power may be large in comparison with the input signal (sometimes several hundred times larger), we have true *amplifying* action.

The exact shape of the control characteristic may be of the utmost importance to the engineer. For instance, where voice, television, or music signals are being amplified, it is essential that this curve be a nearly straight line. Otherwise, the output current will not resemble the input signal, it will be

distorted. In certain scientific or industrial applications, accurate reproduction of the input signal by the output current is not necessary, and more efficiency can be secured by purposely distorting it. Then a highly curved control characteristic is advantageous. Other problems, such as feedback from the output to the input of the system may sometimes arise to complicate the designer's plans for a successful amplifier.

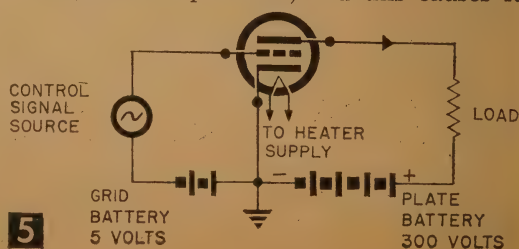
The earliest, highly successful control impedance applied to electrical amplification—the device still called “the king of amplifiers”—is the three-element vacuum tube. First made for “wireless detection” by Dr. Lee DeForest in the early 1900's, the vacuum tube was the amplifier until 1947.

The triode vacuum tube consists first of all of a bulb full of nothing; that is, an evacuated envelope. Placed within this envelope is an electrically heated wire or metal tube called the cathode. When heated to a red, or higher temperature, the cathode boils off millions of negatively charged electrons. Surrounding the cathode is a spiral of wire called the grid. Finally a (frequently) cylindrical electrode, called the plate is mounted coaxially with the cathode and grid, and outward from the latter, as shown in Fig. 4.

Vacuum tubes of myriad shapes and sizes have been made and used since about 1908, but the one diagrammed in Fig. 4 illustrates the principle as well as any. The connections of a basic triode vacuum-tube amplifier circuit are diagrammed in standard schematic symbols in Fig. 5. For simplicity, batteries are shown as the dc supply sources, but they are seldom used in modern practice. Instead, an electronic power supply, operating from the commercial power line is most often substituted. Basic principles remain the same.

When the cathode of the vacuum tube is heated, clouds of electrons collect about it. When a positive potential (positive with respect to the cathode) is placed upon the plate, the negatively charged electrons are attracted to it, and current flows between cathode and plate, around through the load and plate battery and back to the cathode. These electrons must, however, pass between the wires of the grid enroute to the plate.

Normally, the grid is connected to a slightly negative dc potential, and this causes it



5

THE HYBRID COIL

One most interesting modification of the amplifier exists. Although it is an old idea, comparatively few people are aware of it.

As everyone knows, telephone signals lose their "kick" rapidly as they travel down the line. After traversing about 30 miles of ordinary cable pair, the voice signals have been reduced to one-thousandth of their original strength. Thus, amplification becomes necessary to long-distance telephony.

But the telephone is a two-way device. Mrs. Smith in Boston wants both to talk and to listen to Mrs. Brown in San Francisco. In fact, both ladies are often talking at the same time. How can we arrange a two-way amplifier that will amplify the signals equally well in both directions without complex switching, and without getting the signals mixed up?

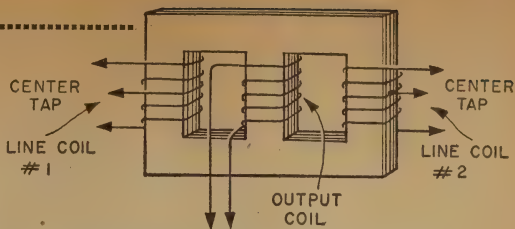
The answer lies in a special kind of transformer called a hybrid coil (see Fig. A). Two identical, carefully balanced coils, the line coils, are connected in series with the two wires of the line. A third winding, the output coil, is arranged to couple its magnetic field equally into both of the line coils. The output coil is connected to the output terminals of the amplifying device, which may be either a vacuum-tube or a transistor. The input terminals of the amplifier are connected to the two center-taps of the two line coils (see Fig. B).

The two line coils have small resistance, about that of a mile or two of line, so the signal can pass through them with little loss. And since the input of the amplifier is connected to the two center taps, it is effectively connected across the line. Thus the voice signals from either Mrs. Brown's or Mrs. Smith's phone will be fed equally well into the amplifier.

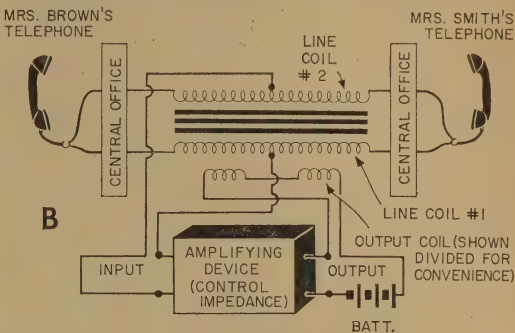
These signals act to vary the battery current in the output circuit via the control impedance. Therefore, a greatly enlarged replica of either or both voice currents flows through the output winding of the hybrid coil. These strong voice currents cause a changing magnetic flux to pass through both line coils in the right direction,

to have a definite repulsive effect upon the electrons. The control-signal voltage source is connected in series with the grid battery so that its variations will add to and subtract from the negative, fixed grid voltage. Thus the signal voltage will make the grid instantaneously more or less negative with respect to the cathode. When the grid becomes less negative, it repels the electrons less strongly, and the cathode-plate-load current increases. When the signal makes the grid more negative, it repels more electrons, reducing the load current. Thus the triode vacuum tube acts as a control impedance whose internal opposition to load current flow is at the command of the grid voltage.

Like all practical devices, the vacuum tube can develop "indigestion" which interferes with its action under some circumstances. To avoid this, more grids have been added which, when properly connected, vastly improve its universality. Also, vacuum tubes ranging from pea-size (for hearing-aids and micro-wave use) to 100-kilowatt giants have been built and are in use as amplifiers on all sorts of jobs today. They're made of metal, glass and special ceramics. Vacuum tubes are shot into outer space on satellites, and are operating miles beneath the surface of the ocean as



A GENERAL ARRANGEMENT OF A HYBRID COIL



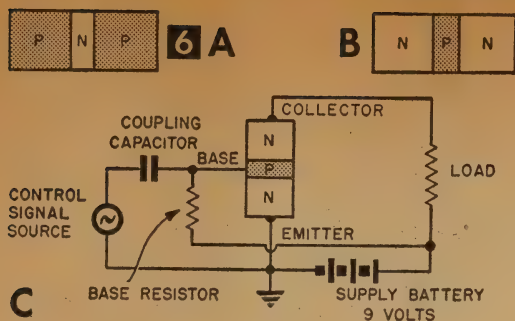
thus inducing a large voice voltage back into the line. This greatly-amplified signal propagates down the line in both directions, giving both parties the benefit of the boost.

Because the input of the amplifier is connected to the exact center of each of the coils, and since half of the signal is sent each way down the line, the amplifier's output voltage, is cancelled out at its own input terminals. Thus, when things are adjusted properly, the voice signals may be amplified many times without annoying "singing," or feedback.

transoceanic cable amplifiers. They work.

The Transistor. In 1947, after countless hours of cogitation upon solid-state physics, quantum mechanics, statistical theory, and (possibly) voodoo, Drs. Bardeen and Brattain, of the Bell Telephone Laboratories brought forth a remarkable new control impedance called the *transistor*. Unlike the vacuum tube, the transistor makes use of conduction through a special kind of solid substance called a semiconductor instead of through a vacuum. The stuff most of the practical ones are made of today is element No. 32, *germanium*, an element recovered as a by-product from the combustion of certain coals.

When it's pure, germanium is an almost perfect insulator. But when the minutest whiff of indium, arsenic, gallium, aluminum, or certain other elements are added, it becomes a semiconductor. By adding the right stuff, in the right amount, one may make at will two different types of semi-conducting germanium, either N-type, or P-type. An N-type germanium conducts practically like copper does, that is, by means of free electrons which may move about inside the crystal. The P-type, however, is missing a few electrons which it should normally contain. These missing electrons, called *holes*, can



move around inside the crystal and conduct electricity too. However, since they're "missing electrons," they're positively charged particles and move in the opposite direction through the system. But they still conduct, nevertheless.

The art of semiconductor fabrication has advanced so far as to allow different zones of the same chunk of germanium to be made into either N- or P-type material. In fact, such technique is necessary in the routine fabrication of a modern transistor. A modern "junction" transistor, the presently most common and practical type is made of a small bar of germanium about $\frac{1}{8}$ in. long and about $\frac{1}{16}$ in. square. This little bar is divided into three alternate zones of P- and N-type material. The finished bar is sealed in a neat case, for convenience and security.

As Figs. 6A and 6B show, two types of junction transistors are thus possible—PNP and NPN. Both operate upon the same basic theory, the main difference being in the polarity of the supply voltages.

Fundamentally, in schematic terms, an NPN transistor is connected into its most generally practical amplifier circuit in the manner shown in Fig. 6C. The magnitude of the voltages and current shown apply to the typical experimenter's transistor. Power transistors are made which are capable of dealing with much greater voltages and currents when necessary.

Connections made to the ends of the bar of N-type germanium are designated the *emitter* and the *collector*, while the thin layer of P-type material in the center of the bar is called the *base*. In normal operation an electron current of about one milliampere flows from the grounded side of the supply battery into the emitter end of the transistor and up toward the base. Here, within the transistor, it divides, about 95% of it flowing through the entire bar and into the load through the collector connection. The remaining 5% flows out of the base connection, through the base resistor, and back to the positive terminal of the battery. This is the resting state of the circuit.

When the control signal source is ener-

gized, it causes an alternating signal current to flow between the base and emitter connections of the transistor. We recall that an alternating current can flow readily through the coupling capacitor, but that this capacitor acts as an open circuit for unvarying, dc battery current. Thus the capacitor prevents the generator from short-circuiting the base resistor, while allowing the ac control signal current to flow with relative ease.

From one point of view, we may think of the base section acting something like a semi-permeable wall, allowing electrons to pass through it in proportion to the base-emitter current. When the signal source current acts in such a direction as to add to the steady base current, its permeability is increased, and more current can flow from the emitter to the collector through the load. On the other hand, when the signal current subtracts from the battery current from base to emitter, base permeability decreases, the collector-load current is forced to decrease in proportion. Thus the load current is at the direct control of the base current from the signal source; the transistor, like the vacuum tube, acts as a true control impedance. And since the magnitude of the base signal current change is always much less than the corresponding load current change, transistors are effective amplifiers.

It is most important to observe here that, while the vacuum tube and the transistors are both control impedances, and thus amplifiers, they differ drastically in one important operational aspect. Whereas the vacuum tube is a voltage-controlled impedance, the transistor is a current-controlled device. Thus, while these two devices may often do similar jobs, they are by no means interchangeable, either in theory or in practice.

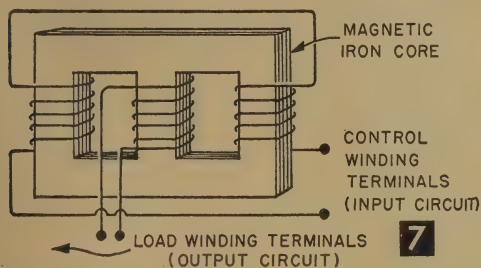
Both the vacuum-tube and the transistor have particular amplifying jobs to do at which each excels. At present, high-quality vacuum tubes are relatively inexpensive, easy to manufacture on a mass scale uniformly, and operate well when the control signal changes rapidly with time, that is, at high frequencies. On the other hand they are relatively bulky, mechanically fragile, and require excessive operating power in the form of cathode-heating requirements.

The transistor is exceedingly compact, operates well with a low-voltage supply source, requires no heating power, and laughs at mechanical shock that would shatter a vacuum tube. But, transistors are exceedingly difficult to manufacture to within close tolerances. Every production run includes a high percentage of rejects which do not meet government and commercial standards. (These culls are what you and I buy for experimenter's projects today, unless we pay over \$5 per unit.) Furthermore, transistors are extremely subject to quick and fatal elec-

trical damage if wrongly connected or allowed to become too warm. Truly effective high-power or high-frequency transistors remain extremely expensive, if indeed they are available to ordinary mortals at all, while vacuum tubes capable of supplying hundreds of watts at hundreds of megacycles may be bought over the counter for a few dollars almost anywhere.

Magnetic Amplifiers: While the vacuum-tube or transistor is still necessary for amplification of signals which change magnitude appreciably in less than one-thousandth of a second, slower signals may be effectively handled by the *magnetic amplifier*.

This interesting device depends for its operation upon the fact that an iron-alloy core, similar to that used in transformers, can, so to speak, pass only a limited number of mag-

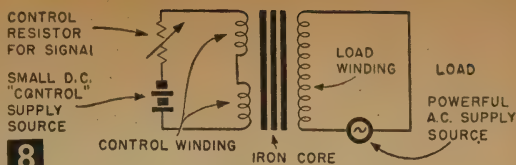


BASIC ARRANGEMENT OF SIMPLE MAGNETIC AMPLIFIER

netic force (flux) lines per square-inch of cross-section area. When such a core has been filled with magnetic flux it becomes very difficult to force any more to pass through it.

The heavy alternating current to the load is made to pass through the load winding (see Fig 7), while a small, possibly slowly changing unidirectional (dc) control current passes through the control windings. Because the two control windings consist of the same number of turns effectively wound in *opposite* directions, the heavy load current induces equal but opposite voltages into each winding, which thus effectively cancel-out in the control circuit. By this means, effective electrical isolation is maintained between control and load circuits. On the other hand, the control currents may still magnetize the core, and exert control action.

A more easily understood schematic diagram of a simple magnetic amplifier circuit is shown in Fig. 8. Assume that the control resistor is of such high resistance that negligible current flows through the control winding. The ac load current then flows through the load winding, developing a large and constantly changing magnetic field within the iron core. This continually changing magnetic field induces an *opposing* ac voltage back into the turns of the load winding. This opposing, self-induced voltage subtracts from the ac generator voltage, thus, reducing the



8

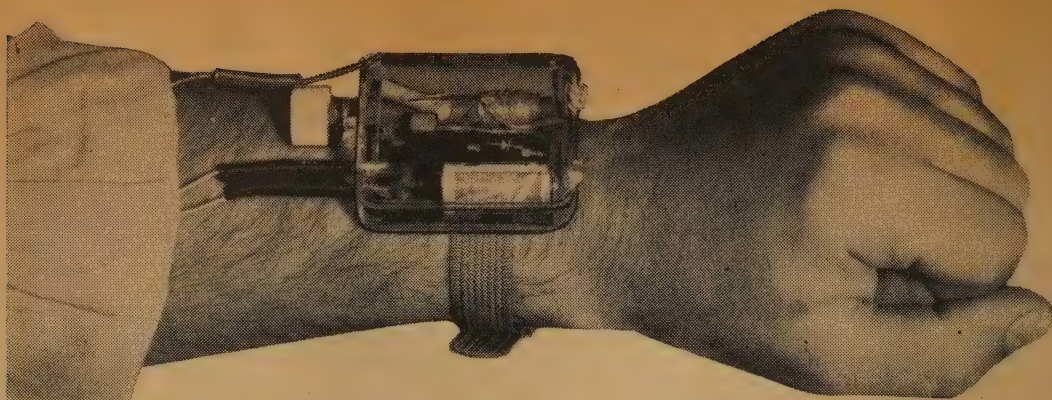
current in the load circuit to a small number of amperes. In other words, the load winding acts as an efficient "choke coil" in the ac load circuit, opposing the flow of current therein.

But now let us pass a small current through the control windings. This current now adds a second set of magnetic flux lines to those present due to the load current. But, as we have just said, the iron core can only contain a certain maximum number of total magnetic lines. Since an appreciable amount of the core's magnetic capacity is now being used by the dc control flux, the ac load current can no longer produce as great a changing field within the core as formerly. Since the opposing voltage induced within the load winding is directly proportional to its own changing field, and this must be appreciably less than formerly, the load winding's "choking" effect is less, allowing more load current to flow.

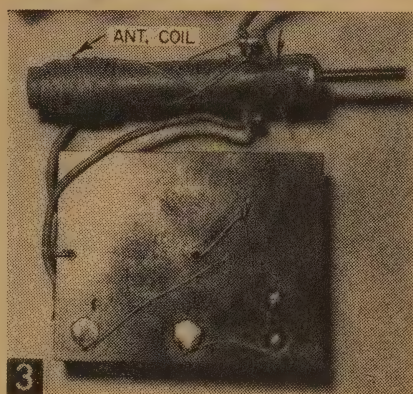
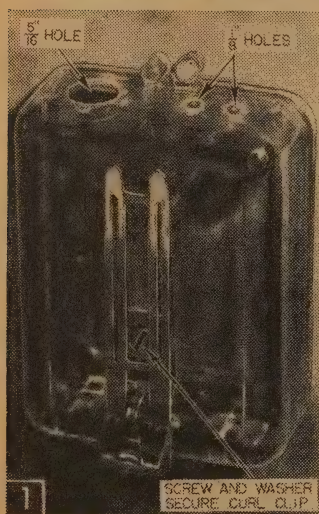
Increasing the steady current further leaves still less "space" within the core for the changing flux about the load coil, so the choking-effect of the latter is reduced still further. Finally, we may increase the control winding current to the point where it almost fills, or "saturates" the iron core. Then, even though the ac load current is still changing as rapidly as before, it can produce little or no changing flux within the coil.

Thus we see that the magnetic amplifier is really nothing but a variable choke coil, whose current-opposing effect is at the direct control of a small direct current in the control windings. Though relatively slow in response, it is a powerful amplifier, finding much use in multi-kilowatt applications. By its use, thousands of horsepower involved in the rolling-mills of a large steel plant may be perfectly synchronized and controlled in an automatized steel-plate production system.

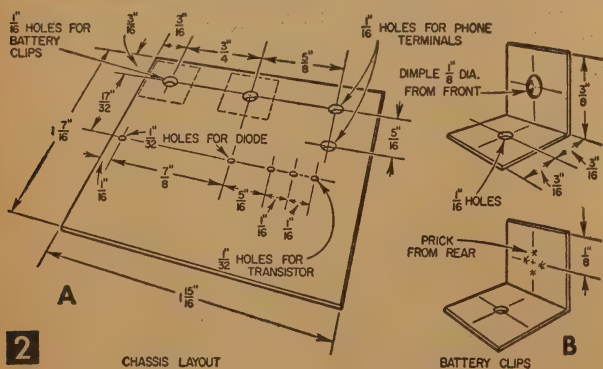
Of course, numerous improvements are possible, and are frequently applied in magnetic amplifier practice. By inserting a rectifier, or electrical "one-way valve" between the control source and the control windings, a magnetic amplifier may be made to amplify low-frequency ac control signals. Also, a feedback circuit by which some of the output power is reapplied to the input circuit, may improve the action and response-speed of the device. Where its inherent slowness is not a disadvantage, the magnetic amplifier is certain to find increasingly wider use, since it is the simplest, longest-lived (practically immortal), most rugged high-powered amplifier we have available at present.



WRIST RADIO



Left, the versatile curl clip is fastened to the case with screw and washer. Holes in end of case are for phone clips and antenna coil. Above, underside of chassis. Virtually all wiring is done with pigtail leads of circuit components.



2

CHASSIS LAYOUT

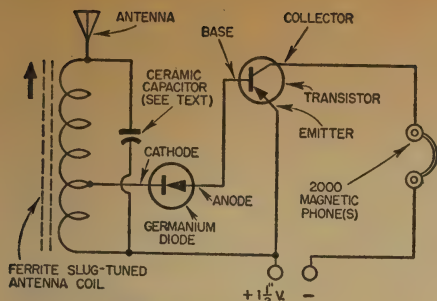
used a $1\frac{1}{16} \times 1\frac{15}{16}$ in. piece of linen impregnated Bakelite. Thin fiber or cardboard can also be used. Lay out and punch the $\frac{1}{16}$ in. holes (Fig. 2A) with a paper punch and pierce the $\frac{1}{32}$ in. holes for diode and transistor with a needle. If you use cardboard for the chassis, dip it in shellac, remove and allow to dry after making mounting holes. Repeat if necessary to give the cardboard the stiffness that fiber or Bakelite has.

Insert the germanium diode and transistor "pigtail" leads into their mounting holes and bend to right angles on the underside of the chassis (Fig. 3).

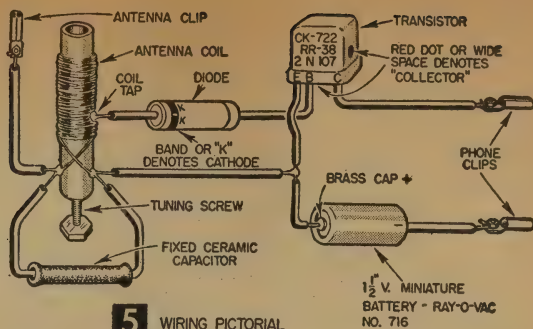
This gives rigidity to circuit components without resorting to ultra-miniature clips and sockets.

Make the battery clips from strips of brass, copper or tinplate as in Fig. 2B. To hold the brass cap end of the battery securely, dent or dimple one of the clips with a $\frac{1}{8}$ -in. flat punch, or

THIS super-small set can—honestly—be called a *Wrist, Clip-On, or Pendant Radio*; its minute size lends itself to these applications without forcing the name upon it as is done so often with sets that should have been labeled *Pocket Radios Only*. It's one-third smaller, and 75%



4 SCHEMATIC



5 WIRING PICTORIAL

MATERIALS LIST—WRIST RADIO

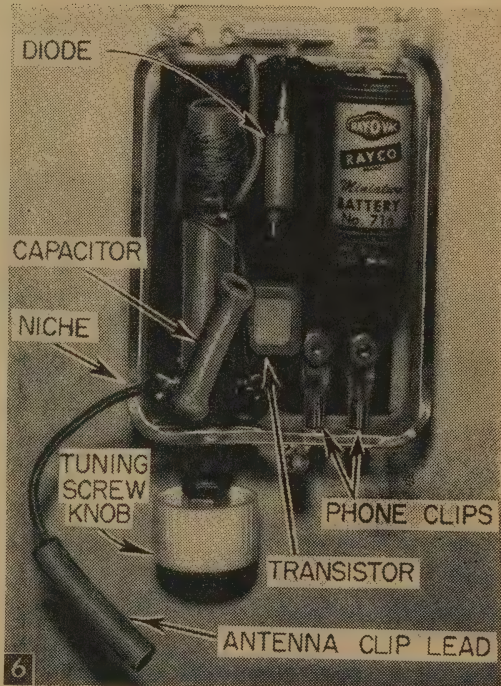
No.	Description
1	Plastic utility box, 2 1/8 x 1 3/4 x 7/8 in.
1	General purpose diode (1N34, 1N66, 1N48, or 1N65)
1	Transistor (CK-722, RR-38 or 2N107)
1	Ferrite antenna coil (Miller, Stanwyck, Grayburne, etc.)
1	Ceramic fixed capacitor (120 mmf. to tune 1590-880 kc.; 220 mmf. to tune 880-550 kc.)
1	Pair standard magnetic headphones, or miniature earphone (D.C. resistance should be 2000 ohms minimum)
1	Miniature flashlight battery (Ray-O-Vac #716 or any other size "N" 1 1/2 v. cell. If mercury type cell should be used, note that cap is minus, not plus as with regular batteries)
3	Tube pin contacts salvaged from octal wafer socket
5	2-56 x 1/8 in. brass machine screws and nuts
1	4-40 nut or 4-40 knob for tuner screw
1	Small alligator clip (or "frictional" paper clip)
1	3 ft. length light, flexible hook-up wire
1	"Lady Ellen" curl clip, 1 7/8" size

machine screw. To prevent the smooth, zinc shell end of the battery from sliding out of position, pierce the other clip with a prick punch or nail. Fasten the battery clips to the chassis with 2-56 machine screws and nuts not more than 1/8 in long and the phone clips with 2-56 screws.

The set uses either standard-size or hearing-aid-size magnetic phones. Standard-size phones have cords fitted with tips, but with the miniature phone you'll have to add them. To do this, carefully remove about 1/4 in. of the insulation from the cord to expose its tinsel conductors. Then place a common pin parallel with the tinsel conductors, and bind pin and tinsel together with a single strand of ordinary stranded fixture wire, snip off the protruding end of the pin and solder.

Suppose you use standard-size phones—then what about the jacks we used? Well, these are nothing more than the pin clips used in cheap octal wafer tube sockets. A 5¢ socket yields 8 of them if you don't have an old socket from which you can salvage the 3 used in this project. If your standard-size phone tips don't fit, simply compress the clips with a pliers until they do.

Except for the coil connections, wire all components on the underside of the chassis with the transistor and diode pigtail leads (Fig. 3); separate hook-up wire is not required. When soldering to the screw terminal points, use a thumbnail-size wad of wet cleansing tissue pressed over the pigtail lead so that heat is not



Set with case open. It measures only 2 1/8 x 1 3/4 x 7/8 in.

transmitted up into the diode or transistor. Just as soon as the solder sets, move the wad over the hot connection so that it will cool rapidly. This protects transistor and diode from damage. Electrical connections are shown in Fig. 4; physical connections, in Fig. 5.

In order to provide the most efficient match between the high-impedance resonant circuit of coil and capacitor and the low-impedance diode detector—which, in turn, feeds into the low impedance transistor—the ferrite slug-tuned antenna coil is tapped 16 turns from the outside end of the winding. Using the coil shown in Fig. 3, which has a progressive type winding, you needn't count off turns; just unwind 21 inches of wire. This is equal to 16 turns. Carefully scrape off the cotton insulation and form a small loop, then rewind the coil wire as closely as possible into its original space and pie-layer arrangement and reconnect the end of the coil to the terminal lug. No great harm will result,

however, if you "scramble wind" the turns back on the coil form.

With two short lengths of light stranded, plastic-covered hook-up wire, connect one coil lug and the tap to chassis components. With a third length, connect the inside coil lug to another octal socket clip. This is the antenna connection. A 3 ft. length of wire fitted with a small alligator clip and brass weatherstrip nail or phone tip attaches to it. Removed from the set when not in use, this type of antenna eliminates dangling wires.

A fixed ceramic capacitor connected across the coil lugs completes the wiring. Its value will depend upon stations operating in your area. If stations tune in between 1590 and 880 kc., the value of the capacitor should be about 120 mmf. To tune from 880 kc. to the top of the dial, 550 kc., use 220 mmf. Solder a 4-40 brass nut to the end of the threaded coil slug, or a small bakelite knob with a 4-40 lock nut, to turn the coil's tuning slug in and out.

When testing the set before installing in its case, attach the alligator clip to the finger stop or metal box of your telephone. If wiring is correct, and the correct size capacitor for your area is across the coil, you may find that powerful local stations are so loud that the earphone is overloaded and reception distorted. If this happens, remove the alligator clip from the phone. The volume will still be loud, but the set will be free of distortion—and quite selective.

Try the antenna clip on metal lamp bases, screens, bedsprings, etc., but you will probably find you can let it hang free and still get good reception.

With the set tested, it's ready for mounting in the case. Drill two $\frac{1}{8}$ -in. holes for the phone clips and a $\frac{1}{16}$ -in. hole for mounting the tuning coil (Fig. 1). Drill a $\frac{1}{16}$ -in. hole in the back of the case for securing the curl clip and slip a $\frac{1}{16}$ -in. dia. washer over a 2-56 screw and clamp the clip between washer and case. The chassis with its wiring friction-fits in the case.

The antenna lead passes through a niche filed between case lid and cover. (Fig. 6.) When not in use, it's tucked inside. Since the case is transparent, a snapshot, colorful floral print or decal can be inserted under the lid when the set is used as a Pendant Radio. There is a $\frac{1}{8}$ -in. hole in the curl clip to which either a ribbon or chain may be attached. As a Wrist Radio, a plain leather strap is all that is required—the set clips to the strap—and as a Clip-On Radio, it clips to tie, shirt pocket, belt.

We've obtained fair results with an aluminum-foil-lined hat as a walking antenna, receiving 50 kw. stations located 20 airline miles away. For so tiny a receiver, mobility is asking a lot, but in many areas this stunt is possible. Note that no ground connection is required for normal reception. In remote areas, of course, a ground may be connected to the battery's minus terminal.—THOMAS A. BLANCHARD.



I don't object to your doing-it-yourself—but I do draw the line at growing your own needles!

Code Practice Oscillators

The article describes two code practice oscillator kits that are easy to build, instructive, and inexpensive

CODE practice oscillators are comparatively simple electronic devices. The simplest use only a single transistor or tube. The output is an audible tone, generally between 400 and 2,000 cycles per second, which the user can hear in an earphone.

The Lafayette KT-72 kit is available for \$2.99 from Lafayette Radio, 165-08 Liberty Avenue, Jamaica 33, New York. It comes complete with key, but the headphone must be bought separately. The Knight 83Y239 kit is available from Allied Radio, 100 N. Western Avenue, Chicago 80, Illinois, for \$3.95. The key and the headphone are not included in the kit and cost \$3.33 more.

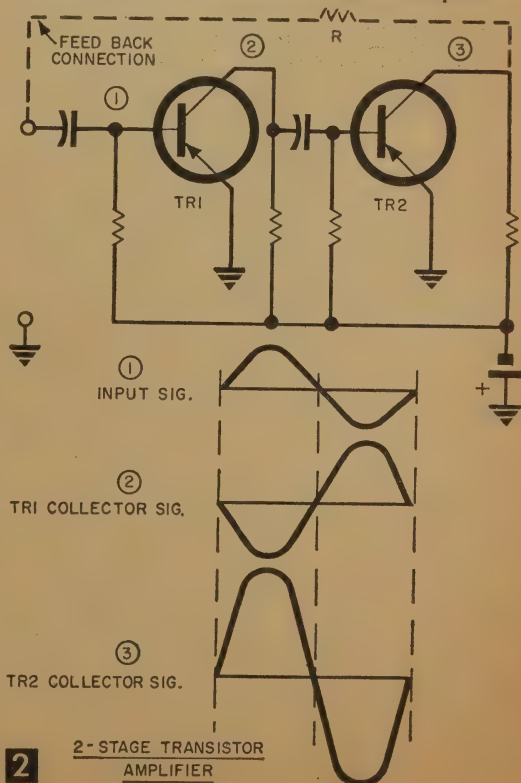
Theory. A small signal voltage at the input to the base of the first transistor shown in Fig. 2 will produce a larger signal at the second transistor (TR2) output. Now even if there's no signal at the input of the amplifier, there's still a very small signal at the first transistor collector made up of noise generated within the transistor and the circuit components. This noise is amplified by the second transistor.

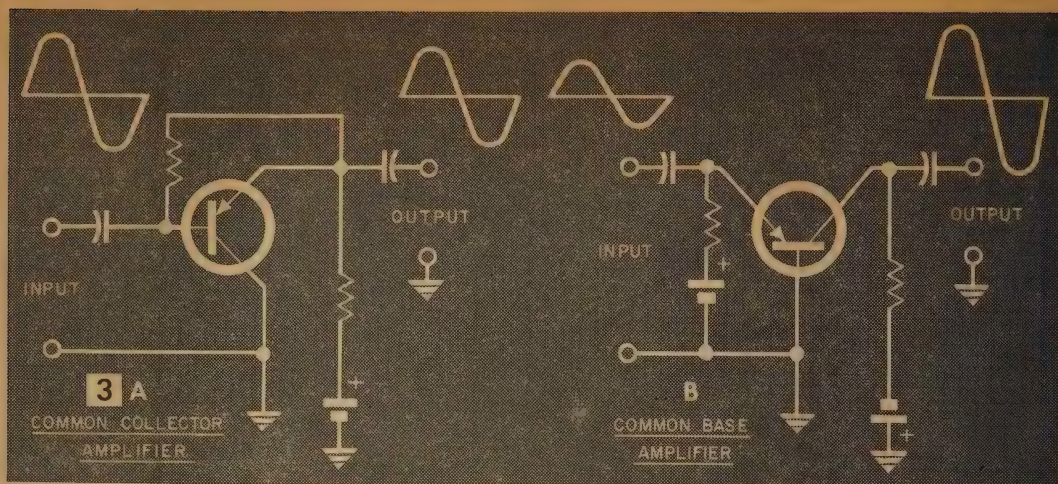
If we were to feed the output of this amplifier back to its input (through a resistance to keep the low-impedance input from partially shorting the higher impedance output), this noise would pass through the amplifier. It would again appear at the output—amplified this time—and it would continue to recirculate in this way until it was prevented from becoming any louder by the value of battery voltage and the parts values employed in the circuit.

Did I intentionally use two transistors to illustrate this? Yes. The transistor circuit configuration used in the circuit of Fig. 2 is called a common emitter circuit because one battery terminal and one input terminal (indicated by the ground symbol) are connected to the emitter. The amplifier in Fig. 2 consists of two cascaded common emitter connected transistors.



The Lafayette Transistor Code Practice Kit completed.

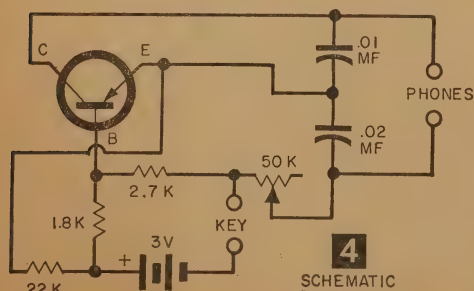




The common emitter circuit configuration is more popular than the common collector and the common base circuits shown in Figs. 3A and 3B because the common emitter circuit has greater power gain and because only one battery power supply is required to operate it. But the common emitter circuit inverts the signal (see Fig. 2). Thus, if we fed some of the output of a single transistor back to its input, the signal would subtract and cancel the tendency to oscillate. This type of feedback is described as degenerative.

However, if two of these transistor stages are cascaded, the signal will be inverted a second time, and when a portion of the output is fed to the input of this two-stage amplifier, the signals are in phase. This results in the build-up required for oscillation.

If a resonating circuit consisting of an inductance (a pair of headphones in the case of this code practice oscillator) and a suitable capacitance *ac* voltage divider combination for feedback is provided, one transistor will produce oscillations. In this case the LC (inductance and capacitor) combination tends to oscillate at a given frequency depending on the product of their values. But the internal *dc* resistance of the headphone windings dissipates energy, and the combination needs a recurring kick of energy—from somewhere—for continued oscillation.



A single transistor can furnish the kick. This type of oscillator is generally known as a Colpitts oscillator, and this circuit is utilized in the Lafayette KT-72 code practice kit. The circuit is shown in Fig. 4.

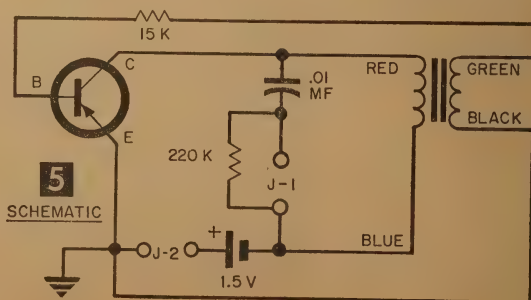
The oscillator circuit of the Knight kit also utilizes a resonant LC circuit, but in this case, feedback is introduced with a transformer. The circuit is shown in Fig. 5.

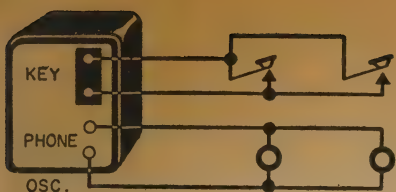
The instructions which come with the Lafayette code practice oscillator kit include a step-by-step wiring sequence. Many of the connections are made without any soldering and rely instead on screws and nuts and Fahnestock clips.

The components are mounted on a perforated Masonite board before any wiring is attempted. The shaft for the volume control must be cut to about $\frac{3}{8}$ -in. length before it is inserted in the volume control. The 50-K volume control is connected as a rheostat (only two terminals are used) instead of as a potentiometer (where three terminals would be used).

The Knight transistor code practice oscillator kit fits in a compact Bakelite case $1\frac{5}{8} \times 2\frac{7}{8} \times 4$ in. with an aluminum front panel. It operates from a single $1\frac{1}{2}$ -v penlite cell. Terminals for connecting key and headphones are provided on the front panel.

The parts in both kits are covered by a

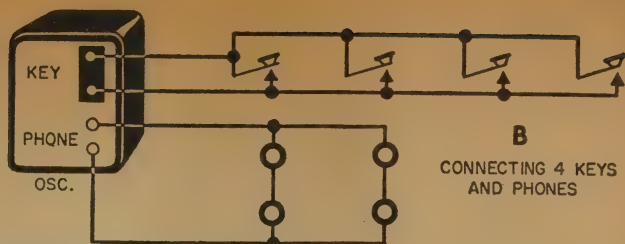




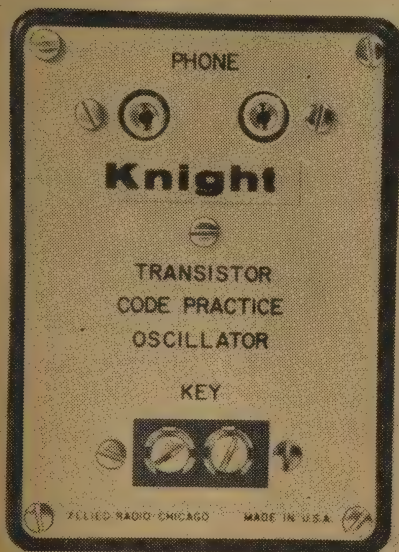
A CONNECTING 2 KEYS
AND PHONES

6

EXTENDING CODE PRACTICE OSCILLATOR UTILITY



B
CONNECTING 4 KEYS
AND PHONES



7

Front-panel view of the Knight Transistorized Code Practice Kit.

standard RETMA 90-day warranty. Any defective parts will be replaced within 90 days provided the damage was not due to carelessness or abuse. Each of the suppliers will troubleshoot your kit for a nominal cost if you can't make it work yourself, but the chance that you'll have trouble with either is very small.

Almost any kind of magnetic headphones of 1,000 ohms or greater impedance may be used with either oscillator. Lafayette recommends a single headphone which may be ordered from them as AM-15-1 at \$1.18. Allied recommends a unit which sells for \$1.08 (59Y112, their catalog number). The key for the Knight Kit may be Allied's 76 PO53 at \$2.25 or Lafayette's MS-309 at \$1.25.

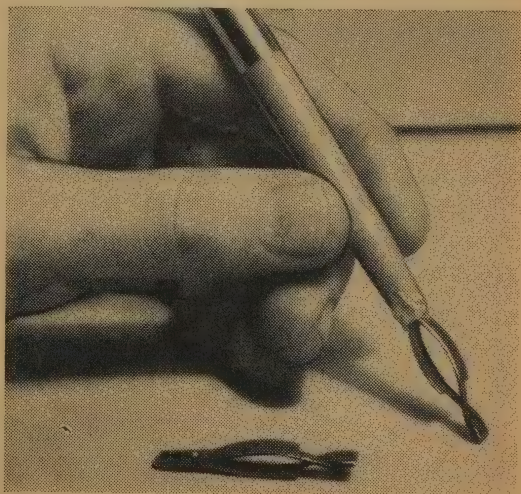
If you wish to use either code practice oscillator with another person, another key and headset may be added as shown in Fig. 6A. If you wish to get as many as four people into the circuit, connect the keys in parallel and the headphones in series-parallel as shown in

Fig. 6B. This kind of operation is a lot of fun and it will help you and your friends learn the code faster.

In comparing the two kits, I find it difficult to recommend one over the other. The Knight Kit is simpler to construct and can be built in less time. It is housed in a very attractive functional package. The Lafayette Kit, on the other hand, is less expensive and it includes the key.—F.H.F.

Soldering "Pen" Absorbs Heat

- Soldering iron heat can ruin transistors and other small electronic parts, unless you use a heat sink. Pliers are often too bulky and heavy for the job, especially in the corners of chassis wiring, or working on minia-



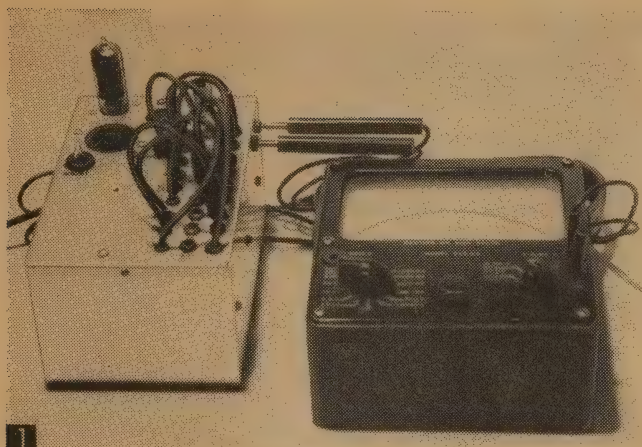
turized circuits. Remove the ink cartridge from an old ball point pen, and saw off the tip about 1/2-in. from the end. Then heat the back end of a Mueller #88 test clip and force it into the pen handle. A drop of cement completes this handy tool.

Draftsman's Tape Holds Tight

- Draftsman's tape makes an excellent "third hand" to hold electronic components together during assembly or soldering. Due to its high insulation, the tape can be left on permanently, or can be peeled off easily.

—J. A. McROBERTS

Adapter Unit Checks Tubes With Your Multimeter



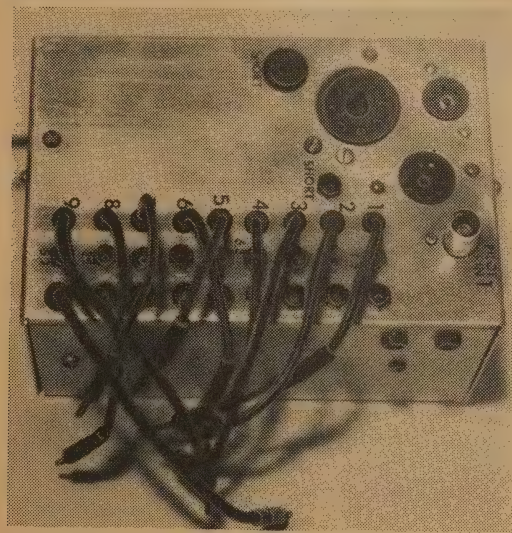
This adapter unit enables you to check tubes with your volt-ohmmeter, makes a fine filament source for experimental setups, and provides multi-ac taps for measurement and calibration work

Figure 2A shows the filament continuity test in schematic form. If a neon tube is connected to an appropriate voltage source, through a tube filament, it will glow brightly. If the filament is open, the neon tube will stay dark. Similarly, if any of the elements

are shorted, and the neon tube is connected through both of them to its source, it will glow again brightly (Fig. 2B). Usually we are interested in shorts to cathode, because they are the most commonly found shorts in tubes.

When a tube is in good condition, the cathode is capable of emitting all the electrons which can be demanded by plate and grid voltages. Actually, the cathode can deliver many more electrons, but there is a finite limit, the saturation current. When a vacuum-tube cathode starts to deteriorate, the first indication is a drop in saturation current. Thus by testing what the saturation current is, we can pretty well determine the condition of the tube. We do this by tying the cathode to ground, heating the filament normally, and applying an ac voltage to all the other elements together. Then we measure the current through the tube, this is the emission test. (See Fig. 3.) Since this measured emission current is the total of that received by all of the elements, when we remove one of them from the circuit, there will be a slight drop in current. Not much, but enough to be perceptible and enough to indicate whether the element in question is open. The recommended *maximum* time to take a reading is three seconds.

Multimeter Requirements. The schematic is shown in Fig. 4. The transformer for the adapter unit is a tube checker transformer with many voltages tapped off. The tapped voltages are supplied to jacks. There are five jacks to a red lead; these supply ac to the elements of the tube under test. There are three black pin-jacks; these are grounded.



Adapter unit at left above (and below) used with volt-ohmmeter for checking tubes.

By TOM JASKI

THE most common and one of the simplest tube tests which can give reasonably reliable information about a vacuum tube is the emission test. Together with tests for continuity of the filament, shorts and opens of the elements, these are the tests that are made when you take your tube to a service shop for a free tube test, and these are also the tests which you perform on do-it-yourself tube testers. With the unit described here and with your volt-ohmmeter you can make these tests yourself.

One of these must be used for one side of the filament, one for the cathode and one is a spare in case you want to ground the suppressor grid also. There are two jacks for the meter, one red for the positive prod, one black for the negative meter prod. The neon tube circuit was shown in Fig. 2. Each lead of the group of nine flexible black leads with phone tips on the ends is connected to a numbered pin on the tube test socket S. Lead one connects to all the #1 pins, lead two to all the #2 pins, etc. These are plugged into the appropriate jacks when you are using the unit.

The meter must have at least a 100 *ma* scale and preferably a higher one. If your multimeter does not have a scale as high as 100 *ma*, make a shunt to use with whatever scales you have. If you have only an ordinary 1 *ma* meter, you can use this provided you make a shunt for it which has a resistance of $\frac{1}{99}$ th of the meter internal resistance, for the 100 *ma* range, or $\frac{1}{998}$ th for the 200 *ma* range. The reason your meter needs these high ranges is that the saturation current of cathodes is considerable, in some cases over 200 *ma*. (In regular emission tube checkers, this is com-

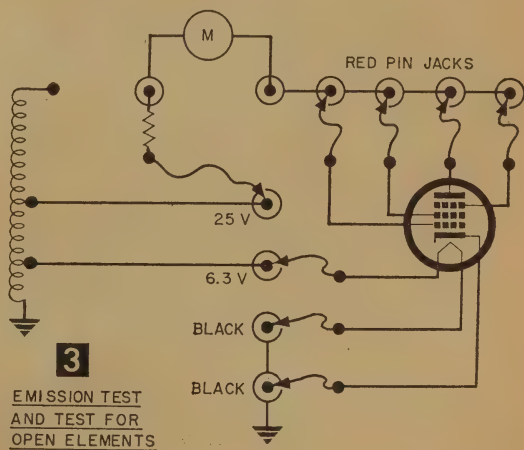
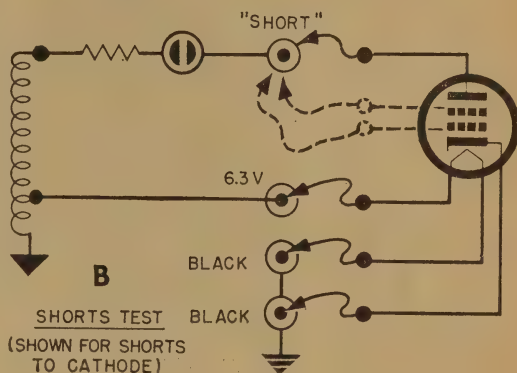
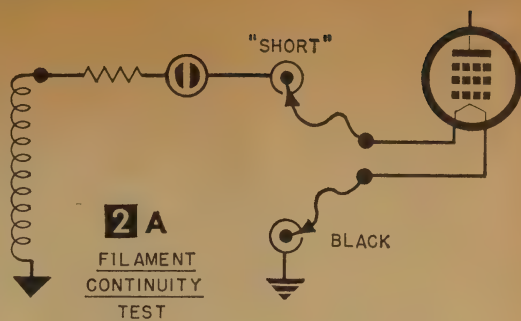
TABLE A

EMISSION CURRENT AND TEST VOLTAGE OF REPRESENTATIVE TUBES

For other tubes, refer to tube manual. Similarity for emission test can be judged from maximum dissipation, maximum plate current and voltage or max. cathode current.

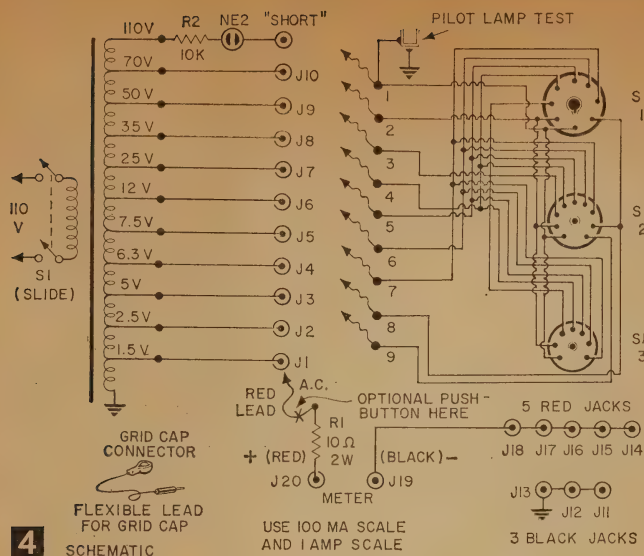
(For dual tubes, the figures refer to each section separately with the other section unconnected.)

Type	Test Voltage	Current (ma)
5U4G	70	180
5Y3	70	60
5Y4	70	65
5Z3	70	70
6AG5	25	65
6AH6	12	70
6AK5	25	65
6AL5	12	50
6AQ3	35	80
6AU6	12	60
6BA6	12	40
6BC3	12	70
6C4	25	65
6J6	25	40
6L6	50	200
6SL7	25	50
6SN7	25	75
6V6	35	90
6X4	50	100
6X5	50	90
12AU7	25	75
12AX7	25	50
12SN7	25	80
25L6	35	160
25Z3	35	150
25Z6	35	140
35L6	25	140
35W4	25	140
35Z3	25	140
50B3	35	160
50C3	35	140
50L6	25	180



pensated for by a *dc* voltage circuit which counteracts the deflection of the meter.)

Plug in the adapter unit, but do not yet turn it on. Find the base connections of the tube you wish to check from a tube manual. (Electronic supply stores have good tube manuals available for from 25¢ to 75¢.) Plug one of the filament terminals into a black pin-jack, the other into the appropriate voltage jack. For split filament tubes, use the entire filament. For example a 12AX7 can be used on 6.3 and 12.6 *v*, but in this case you would use the 12.6-*v* tap and apply it to either pin #4 or pin #5, with the other one connected to the ground jack. Next, determine what the cathode is. On 7-pin miniature tubes, for ex-



ample, it will usually be either pin #2 or #7. Plug it into a black pin-jack. If the suppressor grid is internally tied to the cathode, ignore its pin # lead. If it isn't, plug it into a red jack.

Now plug all the remaining element leads which are appropriate into red jacks. Of course on a 7-pin tube you will have two unused leads. If a tube socket has no connection to, say, pin #6, this lead will not be used. Hang the leads away from the box, in case there is an internal connection in the tube.

Insert the meter prods, and make sure the meter is at least on the 100-ma range. Observe meter polarity. (Note that so far we have done nothing with the red lead which supplied ac to the red jacks.) Turn the unit on, and let the tube warm up for about a minute. Then select the proper ac voltage and plug in the red tip to that particular jack. In table A, a representative group of tube types are listed, together with the voltage which should be used to test them and the current the meter should read for a good tube. Tubes which belong to the same family can be found in your tube manual. For example a 12AY7 is tested with the same voltages as a 12AU7, draws a bit more current.

As soon as you plug in the red lead, read the meter and unplug it again. Don't leave the red lead connected any longer than necessary. If you don't want to plug and unplug a hot lead, build in a normally open "test" pushbutton so that this lead can be plugged in ahead of time and pushed on as needed.

If the tube reads the approximate current listed in Table A, or a value you calculate must be about right from similar tube listings, it passes the emission test. If it reads only 60% of these values, the tube is doubtful. If it reads only 50%, reject the tube.

Construction. Front panel layout is shown

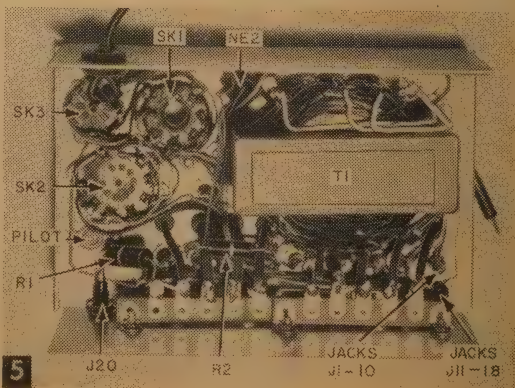
in Fig. 1; internal construction in Fig. 5. The flexible leads are anchored on the tie-point strips, so they won't pull out. You could solder them directly to one of the tube sockets, but then they must be made longer. There is nothing critical about the layout, just make sure the leads are long enough to reach all of the jacks. A bayonet type socket is included for testing pilot lamps. If you expect to check other types of tubes, with different bases, there is nothing to keep you from including as many different kinds as are available—simply use a larger box.

The shorts and filament continuity tests have not been discussed in detail, but once you know how to set up a tube for the emission check, it is obvious from Figs. 2A and B what must be

done for the others. Simply plug in the appropriate leads, one at a time on the shorts test. Don't be alarmed if the neon tube glows slightly when you test the cathode to filament short (which is done by simply plugging the cathode lead in the "short" jack). There is always some leakage between cathode and filament, and only if the tube lights up brightly should the tube be rejected.

MATERIALS LIST—ADAPTER UNIT

No. Req'd	Description
1	transformer (T1) Stancor P-1834-3—tube checker transformer (or equivalent)
1	octal socket
1	7-pin miniature socket
1	9-pin miniature socket
21	phone-tip jacks
10	phone tips
1	resistor, (R1) 10 ohms, 2 watts
1	resistor, (R2) 10,000 ohms, 1/2 watt
1	pilot lamp socket, bayonet type
1	NE2 neon lamp
1	DPST slide switch (S1)
1	grip-cap connector
3 ft	extra flexible test lead
2	5-point tie-point strips
1	3 x 4 x 6" box
1	hardware, wire and solder, decals
1	pushbutton switch for "Test" (optional)



Under-chassis view of adapter unit.

One-String Electric Guitar

How one string and an earphone make music for you

BY ART TRAUFFER

MELLOW, rich and vibrant are the tones produced by this experimental unit. It can be built in an evening, and will play notes ranging through $1\frac{1}{2}$ octaves.

Ordinarily, the magnets in an earphone cause the diaphragm to vibrate, making sound. This instrument uses the same principle in reverse: when the steel string (Fig. 1) vibrates, voltage induced in the coils produces a musical tone when fed through an amplifier. You can plug the unit into the phono jack of a radio, TV set, phono amplifier or tape recorder, and when you move the sliding block (Fig. 2), the pitch of the note varies as you pluck the string.

Cut a piece of straight 1 x 2-in. lumber about 28-in. long. Sand it perfectly smooth (the block must slide easily), and then give it two coats of varnish or shellac. About 1 in. from each end center the $\frac{1}{4}$ -in. long rh wood screws. These screws allow for height adjustment and their slots support the string above the board.

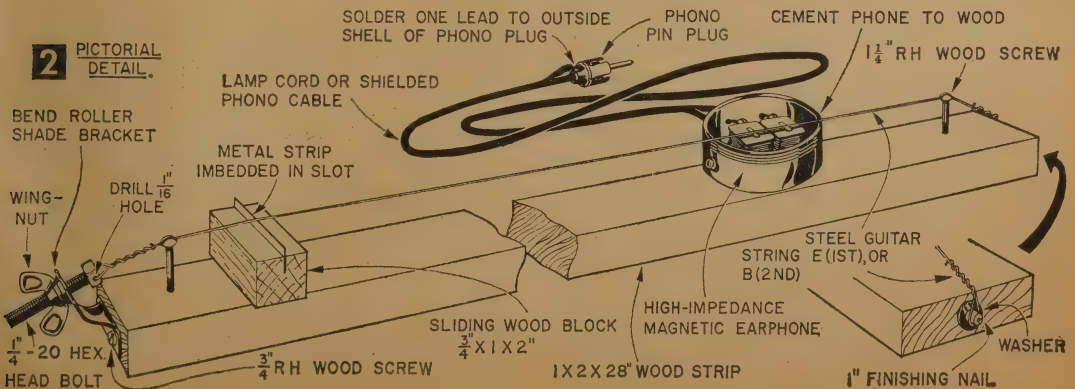
You can use either a "B" or "E" steel string. Obtainable in any music store, these strings are the two highest pitched strings on a standard 6-string guitar. Usually they are



Connect the one string electric guitar to the phono plug of your amplifier, radio, TV set, or tape recorder. Be sure that your set is properly grounded for safety.

supplied with a loop or factory made collar at one end. Fasten this to one end of the board, with the nail and washer assembly shown in Fig. 2.

The tie post which holds the other end of the string is made of a roller window shade mounting bracket. Drill the center hole out to $\frac{1}{4}$ in., bend the bracket as in Fig. 2, and



MATERIALS LIST—"ONE-STRING ELECTRONIC GUITAR"

Amt.	Description
1	1 x 2 x 28" hardwood strip
1	1 x 3/4 x 2" wood block
1	metal strip 1/2 by 2"
2	1 1/4" x 8 rh wood screws
2	3/4" x 5 rh wood screws
1	1/4-20 wing-nut
1	1/4 x 20 x 1" brass bolt, hex-head
1	roller-shade bracket
1	1" finishing nail, or fh nail
1	3/8" dia. washer
1	high-impedance magnetic earphone (1,000—2,000 ohm, higher ohmage preferred)
5 ft	lamp cord, or shielded phono or mike cable
1	phono pin plug
1	Gibson steel guitar string (E or B)

mount it on the end of the board with two 3/4-in. rh wood screws. Now drill a 1/16-in. hole for the string through the head of a 1/4-20 x 1-in. hex-head screw.

The pickup is made of a discarded earphone of high impedance, between 1,000 and 2,000 ohms dc resistance, and with magnet coils in good working condition. Remove the outside screw cap and the metal diaphragm disc. Then cement, or screw the phone onto the wood board about 5-in. from one end. If your earphone has cord terminals on the back side, you may have to cut grooves in the board for the cord. This connecting cord can be made of ordinary lamp cord, with a phono-pin plug soldered at one end. However, if you find later that there is objectionable hum pickup, you may have to substitute shielded phono or mike cable.

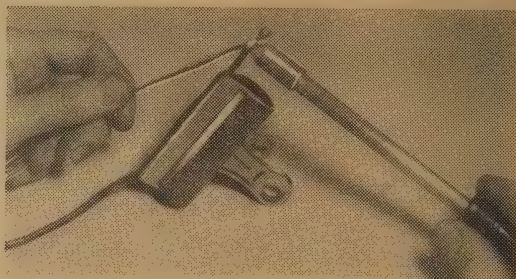
Make the sliding wood block 1 in. wide by 3/4 in. high and about 2 in. long. With a thin-bladed hacksaw, cut the slot in the top to accept a thin strip of sheet metal.

Stretch the strings over the heads of the supporting screws, thread the end through the hole and twist the end securely. Turn the wing nut slowly until the string is taut enough to produce a medium pitch. For best results the space between the string and the tops of the magnets should be as small as possible, but not so the string hits the phone when it is plucked. Plug the phono tip into the jack of your hi-fi amplifier, a radio, TV or recorder. The instrument is now ready to play.

Safety note. In most types of ac-dc radios (having no power transformer), the chassis is hot and hence, if the power is not polarized, the string of the instrument could also be "hot," and serious electrical shock could result. Be cautious about using this instrument on, or near damp floors, or near radiators, etc., and if in doubt, have your phono input jacks checked for safety by a radio serviceman.

How It Works. In theory, this one-string "guitar" works like a musician's electric guitar with magnetic pickup. When the steel guitar string vibrates in the magnetic field of the earphone pole pieces, the string

cuts the lines of force between the poles and induces a small e.m.f. (electromotive force) in the coils. This e.m.f. is amplified by an audio amplifier, or by the audio section of a radio or TV, and then reproduced by a loudspeaker. The tone you hear depends on the rate of vibration of the string. A 1000 c.p.s. tone means that the string is vibrating 1000 times per second. The amplitude of the tone depends on the strength of the strings vibration, the gain of the audio amplifier, and on the spacing between the string and the magnets.



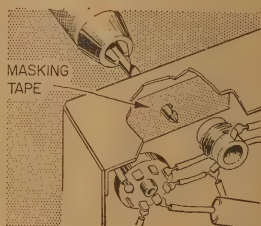
Clamp Holds Wire for Soldering

• When tinning the tips of electric wires and soldering on lugs, use a large paper clamp to hold the wire still and keep it from rolling while you touch the iron and solder to the wire's tip.—JOHN A. COMSTOCK.

Drilling Chassis Holes

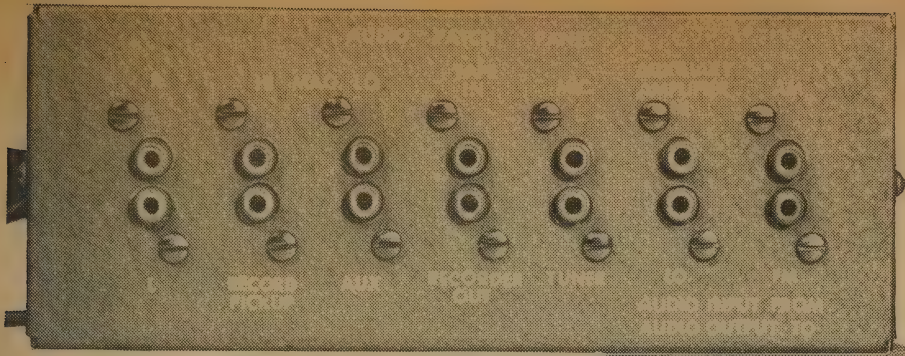
• When drilling holes in the metal chassis of electronics gear, there's a good possibility that some of the metal chips will fall between contact points on the underside of the chassis and cause a short circuit.

To prevent this, apply a wide strip of masking tape to the underside of chassis where the drill will come through, to catch and hold the chips. Once the hole has been drilled, remove the tape, being especially careful not to spill the metal chips.



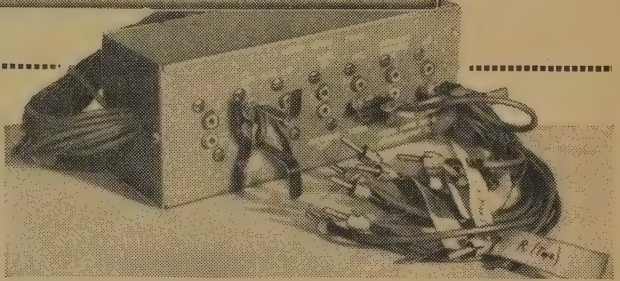
SOLUTION TO
ELECTRON
TUBE
ANAGRAM
Page 130

H	E	P	T	O	D	E		S	H	A	R	P
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1

The far-flung connections made by the connectors in the foreground of the photo at right are all brought into one plane for easy handling in the patch-panel. A patch plug and patch cord are shown plugged in to connect inputs of one unit to outputs of others. On the chassis, lettering stands for: R and L, stereo head; HI and LO MAG., AUX, TAPE IN, MIC., and TUNER, terminations found on rear panel of a DB-110 amplifier; AM and FM are tuner outputs, as is RECORDER OUT; RECORD PICKUP jack connects to monaural disc head; AUXILIARY AMPLIFIER, HI and LO refer to inputs of a second amplifier for stereo; AUDIO INPUT FROM and AUDIO OUTPUT TO refer to color coding that simplifies making connections.



Audio Patch-Panel

Build this \$10 version of a broadcast station patchboard to broaden the use of your hi-fi components

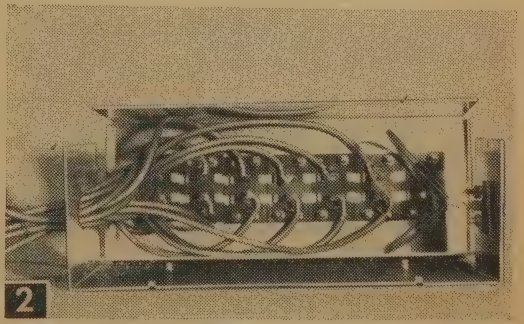
BY DON SCHROEDER

EASY to wire in an evening, this audio patch panel will enable you to set up practically any combination of audio components without delay, and without fumbling for matched cords and connectors.

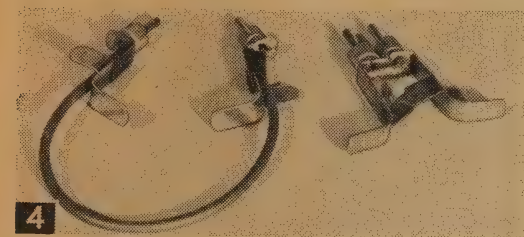
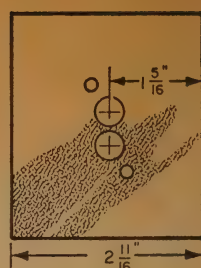
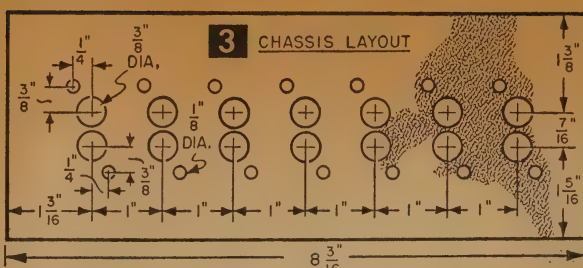
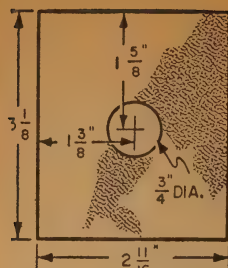
For many years, audio engineers have used patchboards to quickly connect combinations of equipment in broadcast stations, recording studios, and theatres. These panels offer not only convenience, but a complete variety of possible combinations. But the broadcaster has a great advantage over the hi-fi enthusiast in that most of his lines are low impedance and thus less vulnerable to screaming or hum.

This article describes an easily assembled high-impedance patch panel that will greatly facilitate the connection changes required for straight play-back of records, dubbing discs onto tapes, or any other connection it might be desirable to make. With it, all inputs become accessible in one location, eliminating the need to pull amplifiers off shelves or out of cabinets to get access to rear or underside terminals. It also simplifies the adapter fitting problem that plagues most audiophiles because all changes are made with RCA type plugs.

Construction. The patch panel shown in Fig. 1 was designed for use with a Bogen DB-110 amplifier. It therefore includes all those jacks that are present on the back of that model amplifier. It will probably be necessary to change these to suit your particular amplifier. The important thing to bear in



Interior wiring is not difficult and is further simplified by the use of double jacks. All shields are grounded in the box but only one is grounded at the plugs going to any one unit, to avoid ground loops and hum. Two pairs of jacks are connected together at the right. These take care of the tuners which usually come equipped with an output cord.



4 Two plugs are soldered together to make the patch cord (left), the inner connectors being joined with shielded wire. Note that only the right plug connects to the shield on the patch cord, the other end being insulated with tape to prevent ground loops. At right, patch plug.

mind is to keep those combinations most likely to be in constant use above and below each other. For instance, the magnetic input will most often be connected to the magnetic cartridge. Therefore those jacks representing magnetic input and magnetic cartridge should be vertically aligned. The same is true of a tape input and a tape output.

Double jacks are used to keep hole drilling to a minimum, two less mounting screws being necessary. Handy-Grip plugs were used on the patch cords to make plugging easier. Several of these plugs were soldered directly together to provide easy vertical patching.

Between patch and interconnecting cords a considerable amount of shielded wire stripping is required. For this I usually use a dull knife, a scriber, soldering aid, or nut pick, and a pair of scissors. Cut a ring around the outer jacket about 1 in. from the end and pull the piece of jacket off the wire. Now unravel the shield, pull the strands to one side, and twist them together. Where no termination is to be made to the shield, fan the wires and cut them off. Then wrap with two turns of any kind of tape. With as little pressure as possible cut a circle in the inner plastic insulation—no closer than $\frac{1}{8}$ in. to the earlier cut—and pull the plastic off the end. It is now possible to unravel the protective threads. Bend the inner wires to one side. Then, gripping all the threads, cut them off at the plastic.

Often in the course of soldering, an excess of heat melts the plastic insulation. Skill is the most effective means of avoiding this but a clean, thoroughly tinned and heated soldering iron is a great help. If you use a soldering

MATERIALS LIST—PATCH PANEL

No.	Reqd.	Description
10		Handi-Grip pin plugs, solder type BA #12A904. Mfg. by Workman TV
8		Double pin jack, BA #12A676, Mfg. by H. H. Smith, #1214
50 ft.		microphone cable, Belden 8411, BA #2A102
1		gray aluminum box, 8 x 3 x 2 $\frac{3}{4}$ ", BA #20A501, LMB #137
16		binder head screws and nuts 6-32 x $\frac{3}{8}$ ", BA #19B863 and 19A1014
		connectors to match inputs and outputs of existing components in system.
		Suppliers parts numbers above are for Burstein-Applebee, 1012 McGee St., Kansas City, Mo.

gun, trigger it and allow it to get hot enough to melt solder before touching it to the wire. Simultaneously touching tip, wire, and solder together allows the rosin to run on the wire, giving maximum flux when it is needed. High heat, rapidly applied and quickly removed, does far less damage than prolonged heating at subsoldering temperature.

To minimize the danger of hum from ground loops, shields were connected only at one plug of all patch cords, the other end being carefully insulated with a piece of plastic tape. The same was true of lines running to the units when more than one line ran to the same unit. Only one of the wires going to the amplifier is grounded at both ends. Again these lines were carefully insulated with plastic tape against accidental grounding.

Generally a good rule of thumb with high-impedance lines is that they should not exceed 20 ft. in length. Actually, the shorter the better. If your equipment is spread around the walls of the room it might be wise to regroup it to keep line lengths to a minimum. Should hum occur it can sometimes be relieved by use of the larger Belden #8401 shielded wire in place of the smaller Belden #8411 specified in the Materials List.

Aside from the care required in grounding, construction is straightforward and no difficulty should be encountered. "Audio" Teknicals were used to put the finishing touch on the unit. These are applied like any decal, wetting the surface to ease positioning. Careful blotting with a dry rag sets them in position. After at least 12 hours drying time the decal can be permanently attached by a very light brushing with clear "Cutex" nail polish.

If you have been having a battle keeping track of your audio terminations, try this unit. It pays big dividends in frustration reduction.

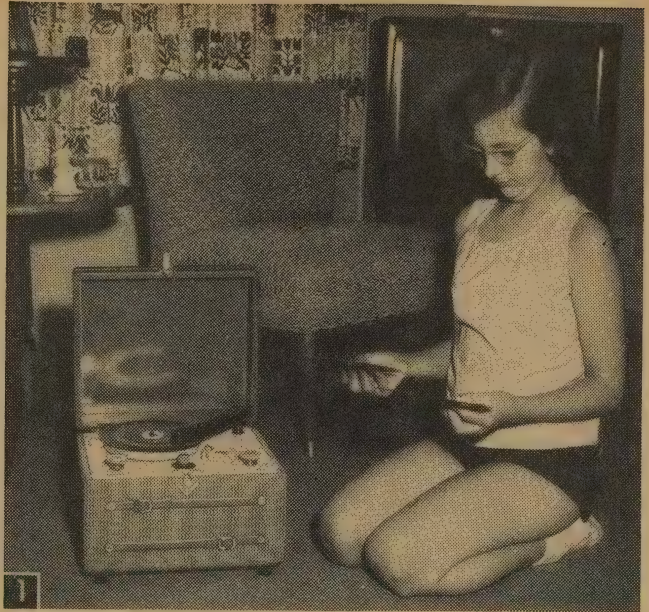
Portable Radio-Phonograph

Here's a transistorized radio and phonograph turntable that operates off batteries. You can take it, and use it, anywhere

By HOMER L. DAVIDSON



Belting and catch on case are available in dime stores.



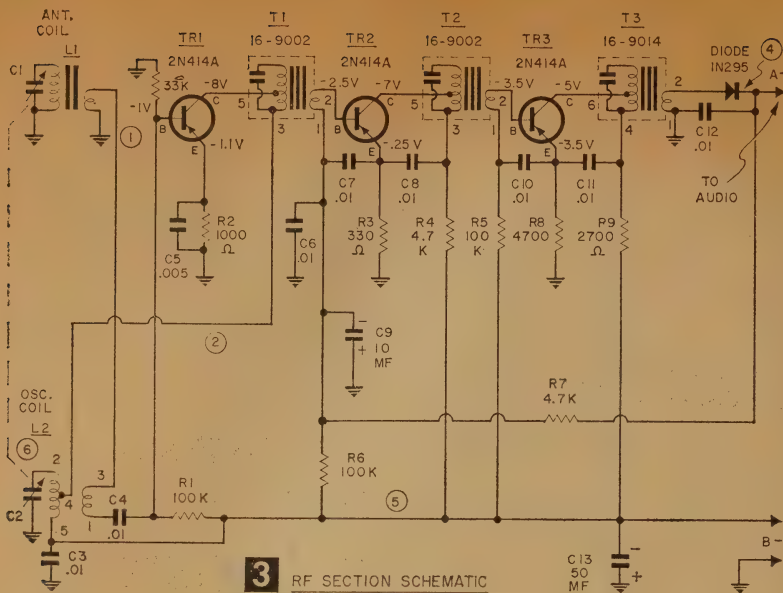
In the home, on the beach, in the air, overseas—wherever you happen to be or go, this radio-phono combination can go with you.

THE RF section of the radio circuit of this portable consists of three RF transistors and a fixed diode rectifier (see Fig. 3). Transistor TR1 is the oscillator mixer stage, TR2 and TR3 are IF amplifiers. The intermediate frequency is 445 kilocycles. This IF signal is rectified to audio frequency by the fixed crystal diode.

A 3 x 11-in. printed circuit board is used as a subchassis for the RF and audio circuit (see Fig. 5 for RF section

MATERIALS LIST—PORTABLE RADIO-PHONOGRAPH

Desig.	Description	Desig.	Description
RF SECTION			
C1, C2	variable capacitor, RF section 6.3 to 123.1 mmfd; osc. section 5.7 to 78.2 mfd—Lafayette M5261	R3	330 ohm, 1/2 watt resistor
C3, C4, C6, C7, C8, C10, C11, C12	.01 mfd disc capacitors	R4, R7, R8	4.7k ohm, 1/2 watt resistor
C5	.005 mfd disc capacitor	R9	2700 ohm, 1/2 watt resistor
C8	10 mfd 25 v elec. capacitor	R10	33k ohm, 1/2 watt resistor
C13	50 mfd 25 v elec. capacitor	L1	ant. loop, 700 mh (Lafayette MS-264)
R1, R5, R6	100k ohm, 1/2 watt resistor	L2	osc. coil (Lafayette MS-265 or equiv.)
R2	1000 ohm, 1/2 watt resistor	T1, T2	Meisner 16-9002 455 kc IF transformer
		T3	Meisner 16-9014 455 kc output IF transformer
		TR1, TR2, TR3	Raytheon 2N414A transistors (PNP)
		diode	Raytheon 1N295 fixed diode
		AUDIO SECTION	
C14	8 mfd 25 v electrolytic capacitor	T5	AR119 Argonne output transformer PRI 500 ohm C, T.; sec. 3.2 ohm
C15	.05 mfd 200 v paper capacitor	SW1	SPST switch on rear of R10
R10	10k volume control, with sw	Batteries	9-volt (Eveready #276 or equiv.)
R11	470k ohm, 1/2 watt resistor	Spk. jack	standard female phono jack
R12	12k ohm, 1/2 watt resistor	1	pickup arm and crystal (PK-89 phono arm and cartridge, Lafayette)
R13	3000 ohm, 1/2 watt resistor	1	6-volt phono motor, 45 rpm, 33 1/3, 16 rpm (Lafayette)
R14	68 ohm, 1/2 watt resistor	1	rotating DPDT switch
R15, R16	10 ohm, 1/2 watt resistor	1	6-volt battery (Eveready #409 or equiv.)
TR4	2N107 GE transistor (PNP)		
TR5, TR6	2N188 GE transistor (PNP)		
T4	AR109 Argonne transformer driver PRI 10,000 ohm; sec. 2000 C.T.		
		PRINTED CIRCUIT	
1 pt.	PE-5 liquid etchant	1	PRLT ball point pen
1	XXXP copper laminated board (3 x 11" cut from 12" piece)	1 roll	tape resist



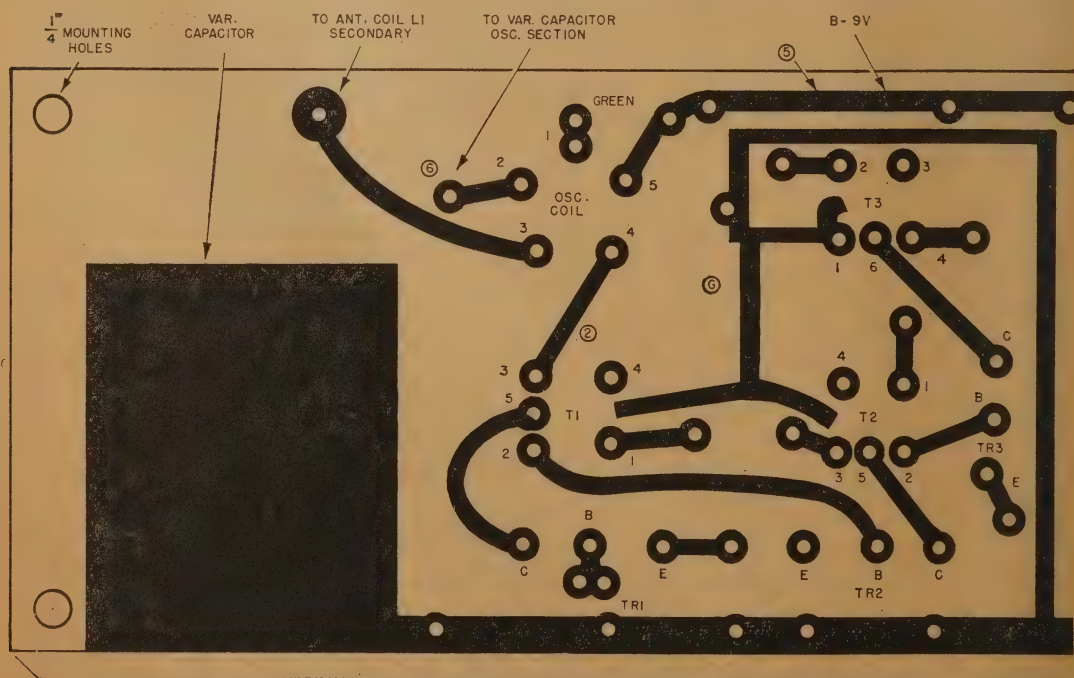
switched into the phonograph circuit, with a separate battery for this circuit since the radio operates off 9 v.

Printed Circuit. Wash the copper side of the PC board with soap and water, and then trace on it the RF and audio circuits through carbon paper. Unroll resist tape and apply, using a sharp pocket knife to cut all corners. Dots can be made with a ball-point resist paint by simply pressing down on the ball point of the pen.

When the circuits have been completely laid out on the printed board, pour enough etching solution into a

and Fig. 6 for audio section portions of the PC board). The audio circuit consists of an audio amplifier with a volume control in the base circuit of TR4. The last two audio stages are operated push-pull for greater amplification. This little portable has two 5 x 7-in. PM speakers in the output and pulls only 10 ma with full volume. A 6-v phono-motor is

tray to sufficiently cover the board. The solution should be agitated or rocked back and forth to quicken the etching process. It will take about one hour to complete the process. Wash the finished board in cold-running water, wash out the etching tray or dish, and pour the remaining solution back into the bottle. It can be used again. Remove the tape



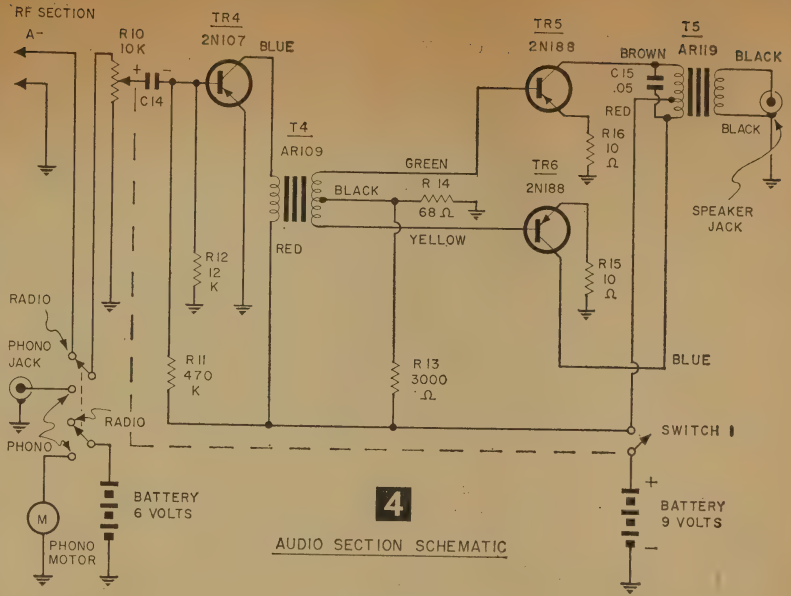
(ACTUAL SIZE)

5 RF SECTION P.C. (SEE FIG. 3)

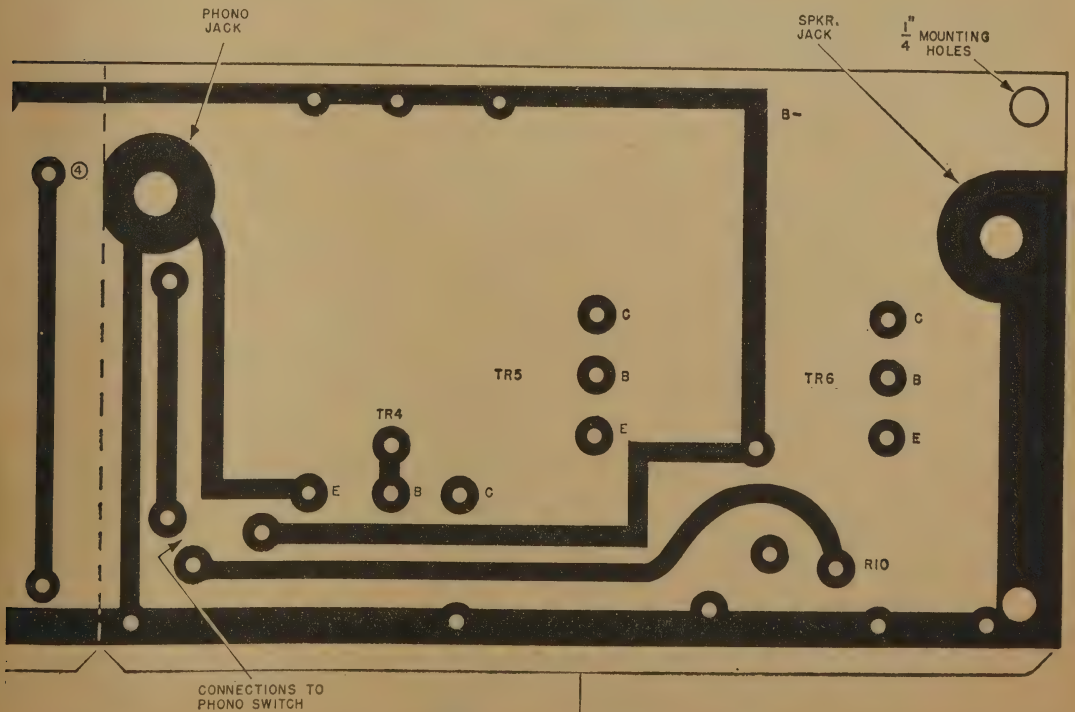
and pen resist paint. Now drill all holes in the printed circuit board before mounting any parts. A very small drill should be used for all small parts such as resistor, capacitors, and transistor wires. The phono and speaker jacks take $\frac{3}{8}$ -in. dia. holes. At the two ends of the printed circuit board drill $\frac{1}{4}$ -in. holes for mounting the PC board on the wooden cabinet.

Mounting Components.

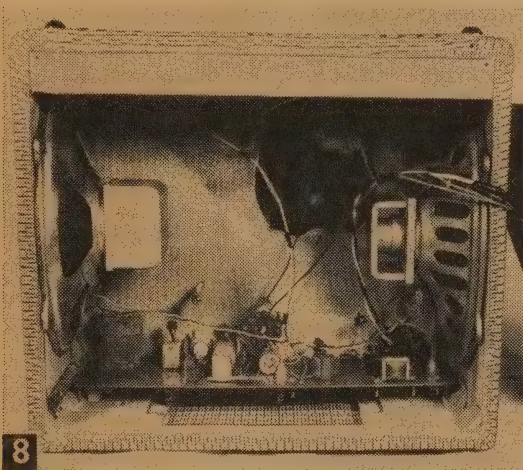
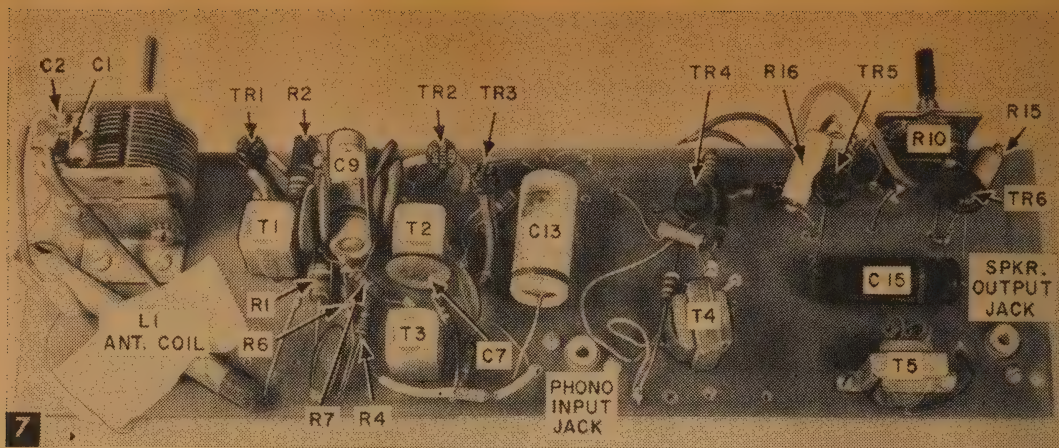
All the small parts are mounted as they are wired into the circuit. Wait until the last thing to solder the transistors into the circuit so that excessive heat on a given point will not ruin them. The variable capacitor and volume control are bolted to the printed chassis, as are the phono and speaker jacks. The small antenna is temporarily taped to the printed board while alignment and mounting is done (see Fig. 7). If you have a signal generator, you already know how to



do the IF and RF receiver alignment. (See "How To Align Superhet Circuits," p. 66, *Radio-TV Experimenter*, No. 559, 75¢ from *Science and Mechanics*, 450 East Ohio Street, Chicago 11, Ill.) If not, the local radio and television shop can easily do a professional job of alignment of the small portable receiver.



6 AUDIO SECTION P.C. (SEE FIG. 4)

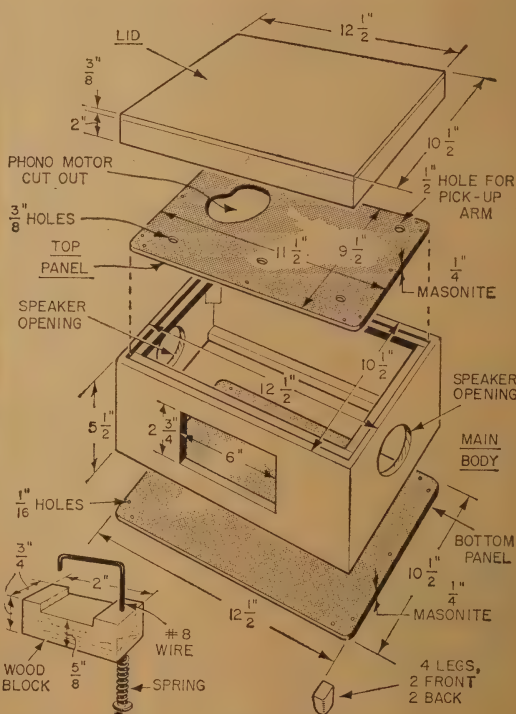


Looking up into cabinet. Speakers mount at opposite ends of case.

Test the audio portion of the printed circuit board first. Do all alignment and testing of the chassis before it is mounted in the cabinet. Turn the switch on and the volume up half-way, and plug the crystal pickup arm into the audio phono jack. A noise should be heard. Rub your finger over the needle and a scratchy sound will be audible. The radio portion can be checked by simply turning the switch to the radio position, and aligning first the IF stages with a signal generator, then the RF section.

Cabinet Construction. After the receiver and phonograph printed circuit board has been thoroughly tested it is ready to be mounted into the cabinet. The cabinet can be made from $\frac{3}{8}$ -in. plywood. If you already have a case, be sure it is large enough to take both chassis and speakers.

The speakers mount at the ends of the cabinet (see Fig. 8). A piece of $\frac{1}{4}$ -in. Masonite was cut and drilled for the top panel to



9 PHONO ARM HOLDER

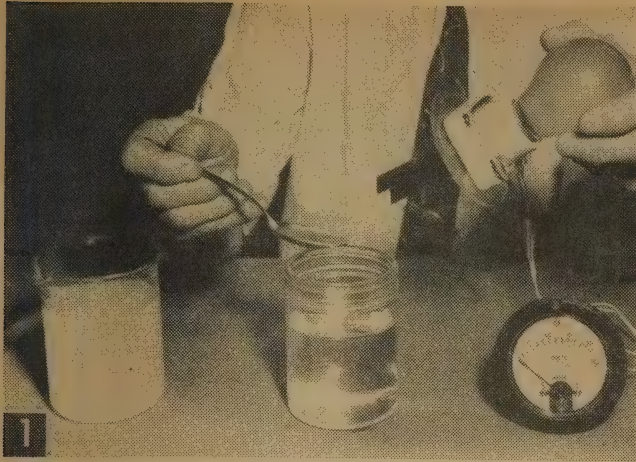
10 CABINET CONSTRUCTION

hold the record player and phono pickup arm, and another piece of $\frac{1}{4}$ -in. Masonite was cut and drilled for the bottom, as in Fig. 10.

Cover the cabinet with plastic grille cloth, stapling it to the case. Apply glue around the speaker holes before stapling. Both Masonite panels and the top phono-lid were sprayed with red enamel paint.

The small batteries were bracketed to the bottom Masonite panel. A small wooden block and No. 8 wire form a holder (see Fig. 9) to secure the phono arm to the cabinet when transporting this portable.

Measuring the Conductivity of Liquids



1 Adding a teaspoonful of saturated solution common salt from beaker at left to test jar of water, upped voltmeter reading from 10 to 112.

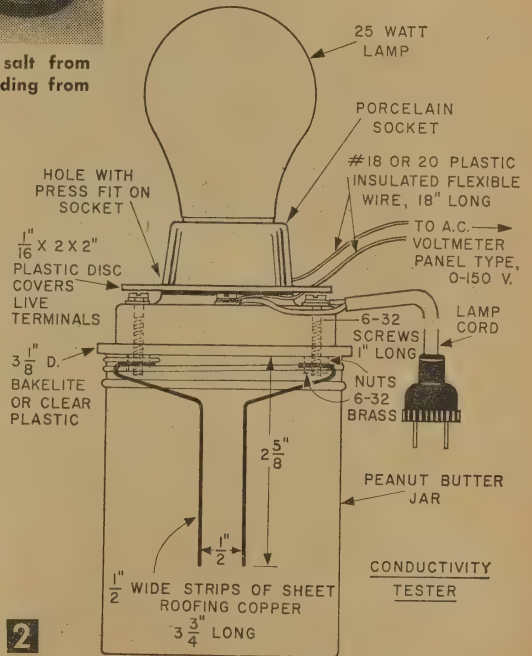
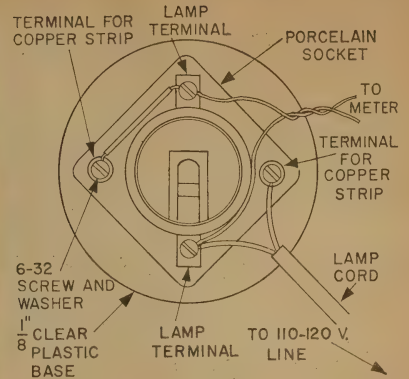
SOME liquids conduct electricity better than others. You can test this fact with the setup shown in Fig. 2. Two strips of sheet copper secured to the underside of a plastic disc are immersed in the liquid to be tested. A meter connected across the lamp terminals indicates voltage applied to the lamp.

With this setup, we found, for example, that the voltmeter registered 10 volts with pure water in the peanut butter jar. We then



3

Teaspoonful of saturated bicarbonate of soda resulted in a lighted lamp and 108-volt reading.



2

added one teaspoonful of a saturated solution of common salt to the pure water (Fig. 1). The voltmeter reading jumped up to 112 volts, and the lamp burned brightly. No wonder medical technicians use salt-soaked pads when attaching various types of electrical equipment to the body!

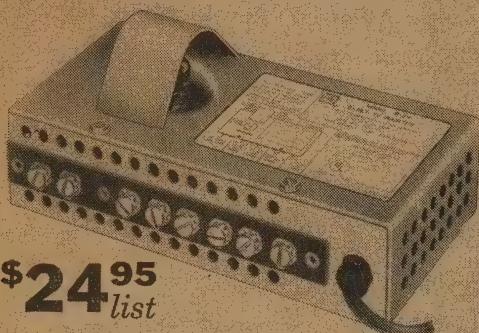
Figure 3 shows an experiment using a teaspoonful of bicarbonate of soda from a saturated solution placed in a fresh jar of water. Here the voltmeter registers 108 volts, as against 112 for salt.

Figure 4 shows how a teaspoon of vinegar results in 58 volts to the lamp, indicating conductivity better than water but not nearly

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'couple-two' circuit provides up to 5 db gain (per set) as an amplified two-set coupler

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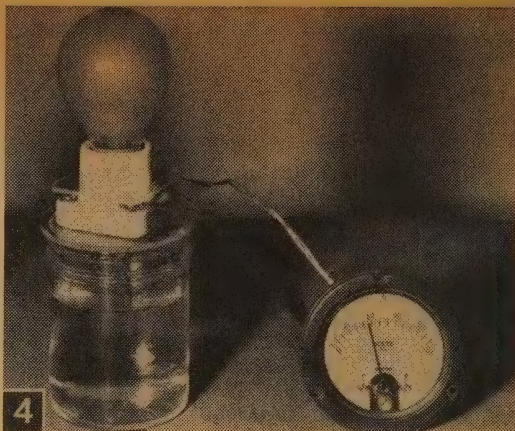
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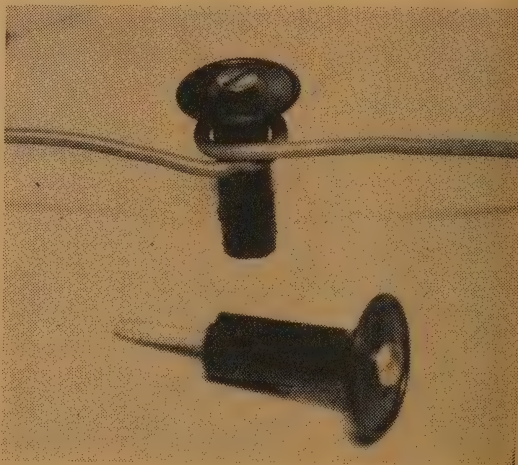
Teaspoonful of vinegar produced reading of 58 volts.

so high as either salt or soda.

For accurate comparisons, use the same quantity of each additive, e.g. a teaspoonful. You'll find salammoniac (ammonium chloride) similar to salt in conductivity. A few drops of dilute sulphuric acid (battery acid) will show a surprising degree of added conductivity to water.

Caution: Do not try any but aqua solutions—an inflammable liquid could easily be touched off in contact with the copper electrodes. Also, don't leave your test setup plugged in, or out where youngsters can poke around its live terminals under the plastic guard ring.—HAROLD P. STRAND.

Film Spools As Wire Stand-Offs



• Those plastic spools that 120 film comes wound around can be made into low-loss, no-cost stand-off insulators for wires such as radio lead-in. Cut the spool in half, drill a hole through the inside and insert a long wood-screw. Wrap one turn of the wire around the insulator near the flange as shown.



WHITE'S RADIO LOG

An up-to-date broadcasting directory
AM, FM, TV and Short-Wave Stations

Vol. 37

No. 2

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U. S. and Canadian AM Stations by Frequency

U.S. stations listed alphabetically by states within groups, Canadian stations precede U.S. Abbreviations: Kc., frequency in kilocycles; W.P., watt power; d—operates daytime only. Wave length is given in meters

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
540—555.5											
CBK Regina, Sask.	5000d		WSAU Wausau, Wis.	5000		WSHE Raleigh, N.C.	500d		KFXM San Bernardino, Cal.	1000	
KVIP Redding, Calif.	1000d		560—535.4			WKBN Youngstown, Ohio	5000		KCSJ Pueblo, Colo.	1000	
KFMB San Diego, Calif.	5000		CFRA Ottawa, Ont.	5000		WNAX Yankton, S.Dak.	5000		WDLP Panama City, Fla.	1000	
WGTO Cypress Gardens, Florida	5000d		CJKL Kirkland Lake, Ont.	5000		WFAA Dallas, Tex.	5000		WPLO Atlanta, Ga.	5000	
WDAK Columbus, Ga.	5000		CFOS Owen Sound, Ont.	1000		WBAP Ft. Worth, Tex.	5000		KGMB Honolulu, Hawaii	5000	
KBRV Soda Springs, Idaho	5000		WOOF Dothan, Ala.	5000d		KLUB Salt Lake City, Utah	5000		KID Idaho Falls, Idaho	5000	
KWMT Ft. Dodge, Iowa	1000d		KYUM Yuma, Ariz.	1000		KVI Seattle, Wash.	5000		WVLK Lexington, Ky.	5000	
WDMV Pocomoke City, Md.	500d		KSFO San Fran., Calif.	5000		WMAM Marinette, Wis.	250		WEEI Boston, Mass.	5000	
WBIC Islip, N.Y.	250d		KLZ Denver, Colo.	5000		580—516.9			WKZO Kalamazoo, Mich.	5000	
WGNG Canonsburg, Pa.	250d		WQAM Miami, Fla.	5000		CJFX Antigonish, N.S.	5000		WOW Omaha, Nebr.	5000	
WDXN Clarksville, Tenn.	250d		WIND Chicago, Ill.	5000		CKEY Toronto, Ont.	5000		WROW Albany, N.Y.	5000	
WRIC Richlands, Va.	1000d		WMIK Middlesboro, Ky.	500d		CKPR Ft. William, Ont.	5000		WGTM Wilson, N.C.	5000	
550—545.1						CKUA Edmonton, Alta.	10000		WARM Scranton, Pa.	5000	
CFNB Fredericton, N.B.	5000d		WHYN Springfield, Mass.	1000		CKY Winnipeg, Man.	5000d		WMBS Uniontown, Pa.	1000	
CFBR Sudbury, Ont.	1000		WMIC Monroe, Mich.	500d		WABT Tuskegee, Ala.	500d		KTBC Austin, Tex.	5000	
CHLN Three Rivers, Que.	500		WEBC Duluth, Minn.	5000		KTAB Tucson, Ariz.	5000		KSUB Cedar City, Utah	1000	
CKPG Prince George, B.C.	250		KWTO Springfield, Mo.	5000		KMJ Fresno, Calif.	5000		WLVA Lynchburg, Va.	1000	
KENI Anchorage, Alaska	5000		KMON Great Falls, Mont.	5000		KUBC Montrose, Colo.	5000		KHQ Spokane, Wash.	5000	
KOY Phoenix, Ariz.	5000		WGAI Elizabeth City, N.C.	5000		WDBO Orlando, Fla.	5000		600—499.7		
KAFY Bakersfield, Calif.	1000		WFIL Philadelphia, Pa.	5000		WGAC Augusta, Ga.	5000		CFCE Montreal, Que.	5000	
KRAI Craig, Colo.	5000		WIS Columbia, S.C.	5000		KFXD Nampa, Idaho	5000		CFCH North Bay, Ont.	1000	
WGGA Gainesville, Ga.	5000		WHBQ Memphis, Tenn.	5000		WILL Urbana, Ill.	5000d		CFOC Saskatoon, Sask.	5000	
KMVI Wailuku, Hawaii	1000		KFDM Beaumont, Tex.	5000		KSAC Manhattan, Kans.	5000		CJOR Vancouver, B.C.	5000	
KFRM Concordia, Kansas	5000d		KPQW Watachee, Wash.	5000		WIBW Topeka, Kans.	5000		CKCL Truro, N.S.	1000	
WCBI Columbus, Miss.	1000		WJLS Beckley, W.Va.	5000		KALB Alexandria, La.	5000		WIRB Enterprise, Ala.	1000	
KSD St. Louis, Mo.	5000		570—526.0			WTAG Worcester, Mass.	5000		KCLS Flagstaff, Ariz.	5000	
WGR Buffalo, N.Y.	1000		CKEK Cranbrook, B.C.	1000		WELO Tupelo, Miss.	1000		KVCY Redding, Calif.	1000	
WDBM Statesville, N.C.	500d		CKCO Quesnel, B.C.	1000		WAGR Lumberton, N.C.	500d		KFSD San Diego, Calif.	5000	
KFYR Bismarck, N.Dak.	5000		CJEM Edmundston, N.B.	1000		WHP Harrisburg, Pa.	5000		WICC Bridgeport, Conn.	1000	
WKRC Cincinnati, Ohio	5000		WAAX Gadsgden, Ala.	1000		WRAQ San Juan, P.R.	5000		WPDQ Jacksonville, Fla.	5000	
KOAC Corvallis, Oreg.	5000		KCNO Alturas, Calif.	1000		KOBH Hot Springs, S.Dak.	5000		WMT Cedar Rapids, Iowa	5000	
WHLM Bloomsburg, Pa.	500		KLAC Los Angeles, Calif.	5000		WRKH Rockwood, Tenn.	1000d		WYFE New Orleans, La.	1000d	
WPAB Ponce, P.R.	5000		WGMS Washington, D.C.	5000d		KDAP Lubbock, Tex.	5000		WFST Caribou, Maine	5000d	
WPAW Pawtucket, R.I.	1000d		WACL Waycross, Ga.	5000		WCHS Charleston, W.Va.	5000		WCAD Baltimore, Md.	5000	
KCRS Midland, Tex.	5000		WKYB Paducah, Ky.	1000		WKTY LaCrosse, Wis.	5000		WLST Escanaba, Mich.	1000	
KTSA San Antonio, Tex.	5000		WVMI Biloxi, Miss.	1000d		590—508.2			WTAC Flint, Mich.	1000	
WDEV Waterbury, Vt.	5000		KGRT Las Cruces, N.Mex.	1000d		CFAR Flin Flin, Man.	1000		KGZE Kailisell, Mont.	2000	
WSVA Harrisonburg, Va.	5000		WMYR New York, N.Y.	5000		CKAR Huntsville, Ont.	1000		WCVP Murphy, N.C.	1000d	
			WSYR Syracuse, N.Y.	5000		CKRS Jonquiere, Que.	1000				
			WWNC Asheville, N.C.	5000		VOCM St. Johns, N.F.	1000d				
						WRAG Carrollton, Ala.	1000d				
						KBHS Hot Springs, Ark.	5000d				

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
WSJS Winston-Salem, N.C.	5000		WESC Greenville, S.C.	5000d		CBM Toronto, Ont.	5000d		WJAT Swainsboro, Ga.	1000d	
KSJB Jamestown, N.D.	5000		SKSY Dallas, Tex.	1000		WBLM Montgomery, Ala.	5000d		KXIC Iowa City, Iowa	1000d	
WFRM Goudersport, Pa.	1000d					KUEQ Phoenix, Ariz.	1000d		WRUS Russellville, Ky.	1000d	
WVFL Mayaguez, P.R.	1000d		670-447.5			KBIG Avalon, Calif.	1000d		WBOK New Orleans, La.	1000d	
WREC Memphis, Tenn.	5000		WMAQ Chicago, Ill.	5000d		KCBS San Francisco, Calif.	5000		WCON Lawrence, Mass.	1000d	
KROB El Paso, Tex.	5000					KSSS Colo. Springs, Colo.	1000		KREI Farmington, Mo.	1000d	
KERD Kermit, Tex.	1000d		680-440.9			KVFC Cortez, Colo.	1000d		KDBM Dillon, Mont.	1000d	
KTBB Tyler, Tex.	1000					WKIS Orlando, Fla.	5000		WKDN Camden, N.J.	1000d	
610-491.5			CHFA Edmonton, Alta.	5000		KYME Boise, Idaho	5000		KJEM Okla City, Okla.	250d	
CHNC New Carlisle, Que.	5000		CHLO St. Thomas, Ont.	1000		WVLN Elvira, Ill.	250d		KPQD Portland, Oreg.	1000d	
CJAT Trail, B.C.	1000		CJOB Winnipeg, Man.	1000		KBOE Oskaloosa, Iowa	250d		WCHA Chambersburg, Pa.	1000d	
CKKL Thompson, Man.	1000		CKGB Timmins, Ont.	1000		WNOP Newport, Ky.	1000d		WDSC Dillon, S.C.	1000d	
CKSN St. Catharines, Ont.	5000		KNBC San Francisco, Calif.	5000d		WFRB Framingham, Mass.	250d		WEAB Greer, S.C.	250d	
WGTB Birmingham, Ala.	5000		WPIN St. Petersburg, Fla.	1000		WTAD Cambridge, Mass.	250d		KDDO Sweetwater, Tenn.	1000d	
KVFL Lancaster, Calif.	1000		WCTT Corbin, Ky.	1000		KPBM Carlsbad, N.Mex.	1000d		KBUH Brigham City, Utah	250d	
KFRS San Francisco, Calif.	5000		WCBM Baltimore, Md.	1000d		WMBL Morehead City, N.C.	1000d		WVSU Crewe, Va.	1000d	
WCKR Miami, Fla.	5000		WNAC Lawrence, Mass.	5000d		WPAQ Mount Airy, N.C.	1000d		WKEE Huntington, W.Va.	1000d	
WDEB Pensacola, Fla.	5000		WDBC Escanaba, Mich.	1000		KRMG Tulsa, Okla.	5000d		WDUX Waupaca, Wis.	1000d	
WCEH Hawkinsville, Ga.	5000		WFQF St. Joseph, Mo.	5000		WVGH Chester, Pa.	1000d				
WRUS Russellville, Ky.	5000		WFRF Binghamton, N.Y.	1000		WBSJ Santurce, P.Rico	1000d		820-370.2		
KDAL Duluth, Minn.	5000		WWRW Rochester, N.Y.	250d		WBAY Barnwell, S.C.	1000d		CFAX Victoria, B.C.	1000d	
WDAF Kansas City, Mo.	5000		WPTF Raleigh, N.C.	5000d		WIRJ Humbolt, Tenn.	250d		KGO San Francisco, Calif.	5000d	
KQJM Havre, Mont.	5000		WISR Butler, Pa.	250d		WJIG Tullahoma, Tenn.	250d		WABW Annapolis, Md.	250d	
WQNT Washington, N.H.	5000		WAPA San Juan, P.Rico.	1000d		KTRH Houston, Tex.	5000d		KCMO Kansas City, Mo.	5000d	
KGGM Albuquerque, N.Mex.	5000		WMP5 Memphis, Tenn.	1000d					WGY Schenectady, N.Y.	5000d	
WAYS Charlotte, N.C.	5000		KENS San Antonio, Tex.	5000d		750-399.8			WKBC N.Wilkesboro, N.C.	1000d	
WTVN Columbus, Ohio	5000		KOMW Omak, Wash.	1000d		WSB Atlanta, Ga.	5000d		WCEC Rocky Mount, N.C.	1000d	
WTV Philadelphia, Pa.	5000					WBMD Baltimore, Md.	1000d		WEDD McKeesport, Pa.	1000d	
KILT Houston, Tex.	5000					KMMJ Grand Island, Neb.	1000		WKVM San Juan, P.R.	2500d	
KVNU Logan, Utah	1000					WHBB Portsmouth, N.H.	1000				
WLSL Roanoke, Va.	5000					KSEO Durant, Okla.	250d				
KEPR Kennewick, Wash.	5000					KXL Portland, Oreg.	1000d		820-365.6		
						WPOX Clarksburg, W.Va.	1000d		WAIT Chicago, Ill.	5000d	
620-483.6									WIKY Evansville, Ind.	250d	
CFCL Timmins, Ont.	1000d					760-394.5			WOSU Columbus, Ohio	5000d	
CKCK Regina, Sask.	5000					KGU Honolulu, Hawaii	1000d		KIKI Honolulu, Hawaii	250	
CKCK Phoenix, Ariz.	5000					WJR Detroit, Mich.	5000d		WFAA Dallas, Tex.	5000d	
KNGS Hanford, Calif.	5000					WCPS Tarboro, N.C.	1000d		WBAP Ft. Worth, Tex.	5000d	
KWSD Mt. Shasta, Calif.	1000d								830-361.2		
KSTR Grand Junction, Colo.	5000d								WCGO Minneapolis, Minn.	5000d	
WSUN St. Petersburg, Fla.	5000								KBOA Kennett, Mo.	1000d	
WTRP LaGrange, Ga.	1000d								WNYC New York, N.Y.	1000d	
KWAL Wallace, Idaho	1000d										
KMNS Sioux City, Iowa	1000								840-356.9		
WVMT Bangor, Maine	5000								WKAB Mobile, Ala.	1000d	
WLBZ Bangor, Maine	5000								WKBN New Britain, Conn.	1000d	
WJDX Jackson, Miss.	5000								WHAS Louisville, Ky.	5000d	
WVNI Newark, N.J.	5000								WVPO Stroudsburg, Pa.	250d	
WHEN Syracuse, N.Y.	5000										
WDNC Durham, N.C.	5000								850-352.7		
WGRW Portland, Oreg.	1000								CKVL Verdun, Que.	5000d	
WVJB Greensburg, Pa.	5000								KCRD Red Deer, Alta.	1000	
WCAY Cayce, S.C.	5000								WYDE Birmingham, Ala.	5000d	
WATE Knoxville, Tenn.	5000								KCOA Denver, Colo.	1000d	
WKFT Wichita Falls, Tex.	5000								WRUP Gainesville, Fla.	1000	
WCAX Burlington, Vt.	5000								WEAT W. Palm Beach, Fla.	1000	
WNNR Beckley, W.Va.	1000								KIMO Hilo, Hawaii	1000	
WTMJ Milwaukee, Wis.	5000								WHDH Boston, Mass.	5000d	
									WKBB Muskegon, Mich.	1000	
630-475.9									KFUO St. Louis, Mo.	5000d	
CFCO Chatham, Ont.	1000								WKIX Raleigh, N.C.	5000d	
CHLT Sherbrooke, Que.	1000d								WJW Cleveland, Ohio	5000	
CFGY Charlottetown, P.E.I.	1000d								WEU Reading, Pa.	1000d	
CFBY Smith Falls, Ont.	1000								WABA Aguadilla, P.R.	5000	
CKBC Winnipeg, Man.	1000								WRAP Norfolk, Va.	5000	
CKOV Kelowna, B.C.	1000								KTAC Tacoma, Wash.	1000d	
CKYL Peace River, Alta.	1000										
WAVU Albertville, Alta.	1000d								860-348.6		
WJDB Thomashville, Ala.	1000d								CJBC Toronto, Ont.	5000d	
KJNO Juneau, Alaska	1000								WHRT Hartsville, Ala.	250d	
KVMA Magnolia, Ark.	1000d								WAMI Opp, Ala.	1000d	
KJMD Monterey, Calif.	1000								KIFN Phoenix, Ariz.	1000d	
KJOW Denver, Colo.	1000								KOSE Osceola, Ark.	1000d	
WMAL Washington, D.C.	5000								KWRF Warren, Ark.	250d	
WSAV Savannah, Ga.	5000								KTRF Modesto, Calif.	1000d	
KIDO Boise, Idaho	5000								WKKO Corra, Fla.	1000d	
WLAP Lexington, Ky.	5000								WERD Atlanta, Ga.	1000d	
KTIB Thibodaux, La.	500								WDMG Douglas, Ga.	5000d	
WJMS Ironwood, Mich.	1000								WMRI Marion, Ind.	250d	
KDWB So. St. Paul, Minn.	1000								KWPC Muscatine, Iowa	250d	
KXOK St. Louis, Mo.	1000								KOAM Pittsburg, Kans.	1000d	
KGWV Belgrade, Mont.	1000d								WSON Henderson, Ky.	500d	
KOH Reno, Nev.	5000								WAYE Dundalk, Md.	500d	
KLEA Lovington, N.Mex.	500								WSSS Fairfarington, Mass.	250d	
WFRD Hickory, N.C.	1000d								KNUJ New Elm, Minn.	500d	
WIFD Wilmington, N.C.	1000								WMAG Forest, Miss.	500d	
WJL Scranton, Pa.	5000								WFMO Fairmont, N.C.	1000d	
WFO Providence, R.I.	5000								WAMO Homestead, Pa.	250d	
KGFX Pierre, S.Dak.	250								WTEL Philadelphia, Pa.	250d	
KMAC San Antonio, Tex.	1000								WLBG Laurens, S.C.	1000d	
KGDN Edmunds, Wash.	5000								WIVK Knoxville, Tenn.	1000d	
KZUN Opportunity, Wash.	5000								WMTS Murfreesboro, Tenn.	250d	
									KFTT Ft. Stockton, Tex.	250d	
640-468.5									KPAN Hereford, Tex.	250d	
CBN St. John's, N.F.	1000d								KSCA Nacogdoches, Tex.	1000d	
KFI Los Angeles, Calif.	5000d								KONO San Antonio, Tex.	5000d	
WOI Ames, Iowa	5000d								WKHO Salt Lake City, Utah	1000d	
WNLD Akron, Ohio	1000										
WHAD Norman, Okla.	1000d								870-344.6		
									WEVA Emporia, Va.	1000d	
650-461.3									WOAY Oak Hill, W.Va.	1000d	
KPOA Honolulu, Hawaii	1000d								WFOX Milwaukee, Wis.	250d	
WSM Nashville, Tenn.	5000d										
KRCT Baytown, Texas	250d										
660-454.3											
KFAR Fairbanks, Alaska	1000d										
KMEQ Omaha, Nebr.	500d										
WNBC New York, N.Y.	5000d										
670-447.5											
680-440.9											
690-434.5											
700-428.3											
710-422.3											
720-416.4											
730-410.7											
740-405.2											

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
880-340.7			920-325.9			960-312.3			990-305.9		
WCBS New York, N.Y.	50000		CJCH Halifax, N.S.	10000		WGOV Valdosta, Ga.	5000		CKNW New Westminster,		
WRRZ Clinton, N.C.	10000		CICJ Woodstock, N.B.	1000		KLER Orofino, Idaho	5000		CFPL London, Ont.	10000	
WRFD Worthington, Ohio	50000		CKNX Wingham, Ont.	2500		WALF Chicago, Ill.	5000		CBV Quebec, Que.	10000	
			WCTA Adulasia, Ala.	5000		WXLW Indianapolis, Ind.	5000		CHEX Peterboro, Ont.	5000	
890-336.9			WVWR Russellville, Ala.	10000		KOEL Oswein, Iowa	5000		CKRM Regina, Sask.	5000	
WLS Chicago, Ill.	50000		KARK Little Rock, Ark.	5000		KJRG Newton, Kans.	5000		WKLF Clanton, Ala.	10000	
WHNG Henderson, N.C.	10000		KES Palm Springs, Calif.	10000		WBVL Barbourville, Ky.	10000		KINS Eureka, Calif.	5000	
KBYE Okla. City, Okla.	10000		KVEG San Luis Obispo, Cal.	5000		WAGM Presque Isle, Maine	5000		KEAP Fresno, Calif.	5000	
			KIUP Durango, Colo.	5000		WORL Boston, Mass.	5000		KFWB Los Angeles, Calif.	10000	
			KREX Grd. Junction, Colo.	5000		WSPJ Detroit, Mich.	5000		KGLN Glenwood Spgs., Colo.	10000	
			KLMR Lamar, Colo.	1000		RSFA St. Louis Park, Minn.	5000		WSUB Grotton, Conn.	1000	
			WMEG Eau Gallie, Fla.	10000		WBKH Hattiesburg, Miss.	5000		WRC Washington, D.C.	5000	
			WGST Atlanta, Ga.	5000		KLKJ Jefferson City, Mo.	5000		WDVH Gainesville, Fla.	5000	
			KAHU Waipahu, Hawaii	1000		WBFB Rochester, N.Y.	1000		WTOT Marianna, Fla.	10000	
CKTS Sherbrooke, Que.	1000		WMOK Metropolis, Ill.	10000		WIBX Utica, N.Y.	5000		WBOP Pensacola, Fla.	1000	
CHML Hamilton, Ont.	5000		WBAW Las Lafayette, Ind.	5000		WPET Greensboro, N.C.	5000		WLOD Pompano Beach, Fla.	10000	
CHNO Sudbury, Ont.	10000		KFNF Shenandoah, Iowa	5000		WNCO Barnesboro, Pa.	5000		WHRT Hartwell, Ga.	1000	
CJBR Rimouski, Que.	10000		WTCW Whitesburg, Ky.	10000		WPEN Philadelphia, Pa.	5000		WBBN Tullahoma, Tenn.	5000	
CKJL St. Jerome, Que.	1000		WBOX Bogalusa, La.	5000		SPAR Spartanburg, S.C.	5000		WRIP Rossville, Ga.	5000	
CJVI Victoria, B.C.	10000		KTCO Jonesboro, La.	5000		KWAT Watertown, S.Dak.	5000		KUPI Idaho Falls, Idaho	10000	
CKBI Prince Albert, Sask.	10000		WPXI Lexington Pk., Md.	5000		WAGG Franklin, Tenn.	10000		WITY Danville, Ill.	1000	
CJGX Yorkton, Sask.	10000		WPLI Hancock, Mich.	10000		KDSX Denison, Tex.	500		KOKA Shreveport, La.	5000	
WATV Birmingham, Ala.	10000		KDHL Fairbault, Minn.	1000		KPRC Houston, Tex.	5000		WCAP Lowell, Mass.	10000	
WKCB Mobile, Ala.	10000		KWAD Odessa, Minn.	1000		KSEL Lubbock, Tex.	1000		WPBC Minneapolis, Minn.	10000	
WOZK Oaz, Ark.	10000		KRAM Las Vegas, Nev.	1000		WXGI Richmond, Va.	10000		WPCN McComb, Miss.	10000	
KPRB Fairbanks, Alaska	10000		KOLO Reno, Nev.	1000		KJRI Seattle, Wash.	5000		KMEC Kansas City, Mo.	5000	
KHOZ Harrison, Ark.	10000		KQEO Albuquerque, N.Mex.	1000		WKAZ Sheboygan, W.Va.	5000		KSGM Ste. Genevieve, Mo.	500	
KBIF Centerville, Calif.	10000		WTTM Trenton, N.J.	1000		WKTL Sheboygan, Wis.	5000		KVER Clovis, N.Mex.	1000	
WJWL Georgetown, Del.	10000		WKRT Cortland, N.Y.	1000					KMIN Grants, N. Mex.	10000	
WSWN Belle Glade, Fla.	10000		WGHQ Saugerties, N.Y.	10000					WTRY Troy, N.Y.	5000	
WMOP Ocala, Fla.	10000		WBBB Greensburg, N.C.	5000					WKLM Wilmington, N.C.	5000	
WCRV Calhoun, Ga.	10000		WMNI Columbus, Ohio	5000					WAAA Win.-Salem, N.C.	10000	
WCJY Macon, Ga.	2500		KGAL Lebanon, Oreg.	1000					WONW Wapakoneta, Ohio	5000	
WJIV Savannah, Ga.	10000		WKVA Lewistown, Pa.	10000					WILK Wilkes-Barre, Pa.	5000	
KSIR Wichita, Kan.	250		WJAR Providence, R.I.	5000					KDSJ Deadwood, S.Dak.	1000	
WKYV Louisville, Ky.	10000		WTND Orangeburg, S.C.	10000					WSIX Nashville, Tenn.	5000	
WLSI Pikeville, Ky.	10000		KEZU Rapid City, S.Dak.	10000					KFRD Rosenberg, Tex.	10000	
KREH Oakdale, La.	2500		WLIV Livingston, Tenn.	10000					KSCV Richfield, Utah	5000	
WCME Brunswick, Maine	5000		KELP Paso, Tex.	1000					WFHG Bristol, Va.	5000	
WATG Gaylord, Mich.	10000		KECK Okeechobee, Fla.	1000					WEKX Chase City, Va.	5000	
KMSJ Minneapolis, Minn.	10000		KTLL Texas City, Tex.	10000					KUTV Yampa, Colo.	5000	
WDDT Greenville, Miss.	10000		KITN Olympia, Wash.	10000					WHAW Weston, W.Va.	10000	
KFAL Fulton, Mo.	10000		KKLY Spokane, Wash.	5000					WCBW Manitowoc, Wis.	5000	
KJSC Columbus, Nebr.	10000		WMMN Fairmont, W.Va.	5000					WPRE Prairie du Chien, Wis.	5000	
WOTW Nashua, N.H.	10000		WKYK Milwaukee, Wis.	1000							
WBRV Boonville, N.Y.	10000										
WSPN Saratoga Spgs., N.Y.	2500										
WAYN Rockingham, N.C.	10000										
WIAM Williamston, N.C.	10000										
KFNW Fargo, N.Dak.	10000										
WAND Canton, Ohio	5000										
WFRE Fremont, Ohio	5000										
WCFA Clearfield, Pa.	10000										
WFLN Philadelphia, Pa.	10000										
WKXV Knoxville, Tenn.	10000										
WCOR Lebanon, Tenn.	5000										
KATL Atlanta, Tex.	10000										
KKGO Conroe, Tex.	5000										
KFLD Floydada, Tex.	2500										
KCLW Hamilton, Tex.	2500										
WAFB Staunton, Va.	10000										
KUEN Wenatchee, Wash.	500										
WATK Antigo, Wis.	2500										
910-329.5			940-319.0			970-309.1			1000-299.8		
CJVD Drumheller, Alta.	1000		CFBC Saint John, N.B.	5000		CKCH Hull, Que.	5000		CKBW Bridgewater, N.S.	1000	
CKLY Lindsay, Ont.	5000		CJCA Edmonton, Alta.	10000		WERH Hamilton, Ala.	5000		WCFL Chicago, Ill.	5000	
CBO Ottawa, Ont.	10000		CJON St. John's, N.F.	10000		WTFB Troy, Ala.	5000		KTOK Okla. City, Okla.	5000	
CJFC Kamour, B.C.	10000		CJST Gadsden, Ala.	10000		KNEA Jonesboro, Ark.	10000		KSTA Coleman, Tex.	2500	
CHRL Roberval	5000		KTKN Ketchikan, Alaska	5000		KBIS Bakersfield, Calif.	10000		KJAT Henderson, Tex.	2500	
KPHO Phoenix, Ariz.	5000		WAPR Douglas, Ariz.	10000		KCHV Coachella, Calif.	10000		WHWB Rutland, Vt.	10000	
KLCN Blytheville, Ark.	5000		KHJ Los Angeles, Calif.	5000		KFEE Modesto, Calif.	10000		KOMO Seattle, Wash.	5000	
KAMD Camden, Ark.	1000		KIUP Durango, Colo.	5000		KFEL Pueblo, Colo.	10000				
KDEO El Cajon, Calif.	1000		WKSB Milford, Del.	5000		WFLA Tampa, Fla.	5000				
KEWB Oakland, Calif.	5000		WJAX Jacksonville, Fla.	5000		WIIN Atlanta, Ga.	5000				
KDXR Oxnard, Calif.	10000		WKXY Sarasota, Fla.	5000		WVOP Vidalia, Ga.	5000				
KPDR Denver, Colo.	5000		KSEI Pensacola, Fla.	5000		KHBC Hilo, Hawaii	1000				
WHAY New Britain, Conn.	10000		WTAD Quincy, Ill.	5000		KAYT Rupert, Idaho	10000				
WPLA Plant City, Fla.	10000		WKCT Bowling Green, Ky.	1000		WMAY Springfield, Ill.	1000				
WGAJ Valdosta, Ga.	5000		WFMD Frederick, Md.	1000		WAVE Louisville, Ky.	5000				
WAKO Lawrenceville, Ill.	5000		WREB Holyoke, Mass.	5000		KSYL Alexandria, La.	1000				
WSUI Iowa City, Iowa	5000		WBCK Battle Creek, Mich.	10000		WCSH Portland, Maine	5000				
WLCS Baton Rouge, La.	1000		WSLI Jackson, Miss.	5000		WAMD Aberdeen, Md.	5000				
WABI Bangor, Maine	5000		KWOC Poplar Bluff, Mo.	10000		WESO Southbridge, Mass.	10000				
WDFB Flint, Mich.	5000		KOFL Gallup, Mont.	5000		WJAN Ishpeming, Mich.	5000				
WCOY Meridian, Miss.	5000		KOGA Ogalla, Nebr.	5000		WJMN Jackson, Mich.	1000				
KOYN Billings, Mont.	10000		WNNH Rochester, N.H.	5000		KOOK Billings, Nebr.	5000				
KYSS Missoula, Mont.	10000		WPAT Paterson, N.J.	5000		KILT No. Platte, Nebr.	1000				
KBIM Roswell, N.Mex.	5000		WBEN Buffalo, N.Y.	5000		WNTA Newark, N.J.	5000				
WLAS Jacksonville, N.C.	10000		WIST Charlotte, N.C.	5000		WEBR Buffalo, N.Y.	5000				
KOJB Minot, N.Dak.	10000		WRRF Washington, N.C.	5000		WCHN Norwich, N.Y.	5000				
WPFB Middletown, Ohio	10000		WEOL Elyria, Ohio	1000		WRCS Ashokie, N.C.	10000				
KPCD Miami, Okla.	1000		WKY Oklahoma City, Okla.	5000		WRIT Canton, N.C.	5000				
WFRB Brookings, Oreg.	5000		KJBE Vermont, B.C.	10000		WICA Fargo, N.Dak.	5000				
WAVL Apollo, Pa.	10000		KFRE Fresno, Calif.	5000		WATH Athens, Ohio	5000				
WGBI Scranton, Pa.	1000		WMAZ Macon, Ga.	5000		KAKO Tulsa, Okla.	5000				
WSBA York, Pa.	1000		WMIX Mt. Vernon, Ill.	1000		KOIN Portland, Oreg.	5000				
WPRP Ponce, P.R.	5000		KIOD Des Moines, Iowa	10000		WJMX Pittsburgh, Pa.	5000				
WORD Spartanburg, S.C.	1000		WYLD New Orleans, La.	10000		WJWF Florence, S.C.	5000				
WJCV Johnson City, Tenn.	5000		WQOM New Orleans, La.	10000		KNOK Ft. Worth, Tex.	10000				
WEPG S. Pittsburgh, Tenn.	5000		KGRJ Bend, Oreg.	250		WDTI Denver, Colo.	5000				
KNAB Frickburg, Tenn.	1000		WESA Charleston, Pa.	250		KREM Spokane, Wash.	5000				
KRIO McAllen, Tex.	1000		WIPR San Juan, P.R.	10000		WVVO Pineville, W.Va.	10000				
KRRV Sherman, Tex.	1000		KIXZ Amarillo, Tex.	1000		WHA Madison, Wis.	5000				
KALL Salt Lake City, Utah	1000										
WVRJ White River Junction, Vermont	10000										
WRNL Richmond, Va.	5000										
KRNE Spokane, Wa.	10000										
KRND Pasco, Wash.	10000										
KUDY Renton, Wash.	1000										
KISN Vancouver, Wash.	1000										
WHSM Hayward, Wis.	10000										
WDOR Sturgeon Bay, Wis.	5000										

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
KCHI Chillicothe, Mo.	2500		KFBI Wichita, Kans.	10000		KSEN Shelby, Mont.	1000		WENC Whiteville, N.C.	10000	
KCFJ Festus, Mo.	5000		KHMO Hannibal, Mo.	5000		KDEF Albuquerque, N. Mex.	10000		KEYD Oakes, N. Dak.	10000	
KRYN Lexington, Nebr.	250000		KHNS Hannibal, Mo.	10000		KGRB Union, N.Y.	5000		WGAR Cleveland, Ohio	50000	
WINS New York, N.Y.	50000		WDIA Memphis, Tenn.	50000		WBBG Burlington, N.C.	5000		WERT Van Wert, Ohio	2500	
WABZ Albermarle, N.C.	10000		KOPY Alice, Tex.	1000		WGBR Goldsboro, N.C.	5000		KGNV Guyton, Okla.	10000	
WELS Kinston, N.C.	10000		WKOW Madison, Wis.	10000		WQCE Akron, Ohio	10000		WJUN Mexico, Mo.	2500	
WIOI New Boston, Ohio	5000					WIMA Lima, Ohio	1000		WRIB Providence, R.I.	10000	
WITT Lewisburg, Pa.	2500		1080-277.6			KNED McAlester, Okla.	1000		WALD Walterboro, S.C.	10000	
WHIN Gallatin, Tenn.	10000		CHED Edmonton, Alta.	10000		KAGO Klamath Falls, Oreg.	5000		WFWL Camden, Tenn.	250	
WORM Savannah, Tenn.	2500		KSCO Santa Cruz, Calif.	10000		WHUN Huntington, Pa.	10000		WCPH Etowah, Tenn.	10000	
KBYJ Amarillo, Tex.	5000		WTIC Hartford, Conn.	50000		WKPA New Kensington, Pa.	10000		WHEY Millington, Tenn.	250	
KMLW Marlin, Tex.	2500		WKLO Louisville, Ky.	5000		WORA New York, P.R.	1000		KLBS Livingston, Tex.	2500	
WELK Charlottesville, Va.	10000		WOAP Owosso, Mich.	2500		WRNO Orangeburg, S.C.	5000		KZEE Weatherford, Tex.	2500	
WMEV Marion, Va.	10000		WYSL Kenmore, N.Y.	10000		WYTC Rock Hill, S.C.	10000		WCMF Big Stone Gap, Va.	10000	
WCST Berkeley Sprgs., W. Va.	2500		WEWO Laurinburg, N.C.	10000		WSNW Seneca Township, South Carolina	10000		WFAA Falls Church, Va.	1000	
WSPT Stevens Pt., Wis.	10000		KWJJ Portland, Oreg.	10000		WAPO Chattanooga, Tenn.	5000		KASY Auburn, Wash.	2500	
			WEPP Pittsburgh, Pa.	10000		WCRK Morristown, Tenn.	10000				
			KRLD Dallas, Tex.	50000		WTAW Bryan, Tex.	10000				
1020-293.9						KCTT Corpus Christi, Tex.	10000				
KPOP Los Angeles, Calif.	5000		1090-275.1			KIZZ El Paso, Tex.	10000		1230-243.8		
WCIL Carbondale, Ill.	10000		CHEC Lethbridge, Alta.	5000		KIBC Midland, Tex.	10000		CFWC Camrose, Alta.	1000	
WPEO Peoria, Ill.	10000		CHIS St. Jean, Que.	250		KPNG Port Neches, Tex.	1150		CHFC Chubbuck, Man.	250	
KDKA Pittsburgh, Pa.	50000		KTHS Little Rock, Ark.	50000		KOLJ Quannah, Tex.	5000		CFKL Schefferville, Que.	250	
			WCRA Effingham, Ark.	2500		KOFE Pullman, Wash.	10000		CFRG Gravelbourg, Sask.	500	
1030-291.1			KNWS Waterloo, Iowa	10000		KAYO Seattle, Wash.	5000		CFYT Dawson City, Yukon T.	100	
WBZ Boston, Mass.	50000		WBAL Baltimore, Md.	50000		KKEY Vancouver, Wash.	10000		CJBO Belleville, Ont.	250	
WBZA Springfield, Mass.	1000		WILD Boston, Mass.	10000		WELC Welch, W. Va.	5000		CFPA Port Arthur, Ont.	1000	
KOB Albuquerque, N. Mex.	50000		WMUS Muskegon, Mich.	10000		WAXX Chippewa Falls, Wis.	50000		CKLD Theftord Mines, Que.	250	
KCTA Corpus Christi, Tex.	50000		KING Seattle, Wash.	50000		WISN Milwaukee, Wis.	5000		CKLD Midland, Ont.	250	
									VOAR St. John, Nfld.	100	
1040-288.3									CKVD Val D'Or, Que.	250	
KHVV Honolulu, Hawaii	5000		1100-272.6						WAUD Auburn, Ala.	250	
WHIE Des Moines, Iowa	5000		KFXA San Francisco, Calif.	10000		WJJD Chicago, Ill.	50000		WBBB Haleyville, Ala.	250	
KIXL Dallas, Tex.	10000		WLBK Carrollton, Ga.	2500		KSL Salt Lake City, Utah	50000		WBHP Huntsville, Ala.	250	
			WHLI Hempstead, N.Y.	2500					WNUZ Talladeega, Ala.	250	
1050-285.5			KYGA Cleveland, Ohio	50000					WIBC Tuscaloosa, Ala.	250	
CFGP Grande Prairie, Alta.	10000		KWPA Bethlehem, Pa.	2500		1170-256.3			KIFW Sitka, Alaska	250	
KCSB St. Boniface, Man.	10000					CFNS Saskatoon, Sask.	1000		KAAA Kingman, Ariz.	250	
CJIC Sault Ste. Marie, Ont.	250		1110-270.1			WCOV Northbrook, Ill.	1000		KRIZ Phoenix, Ariz.	250	
CHUM Toronto, Ont.	5000		CFML Cornwall, Ont.	1000		KCBQ San Diego, Calif.	50000		KCON Conway, Ark.	250	
WRFS Alexander City, Ala.	10000		CFTJ Galt, Ont.	250		KLOK San Jose, Calif.	10000		KFPW Ft. Smith, Ark.	250	
WCRI Scottsboro, Ala.	2500		KWLA Pasadena, Calif.	10000		KOHO Honolulu, Hawaii	1000		KBTM Jonesboro, Ark.	250	
KVVM Show Low, Ariz.	2500		WALT Tampa, Fla.	10000		WLBN Mattson, Ill.	2500		KWTC Bakersfield, Calif.	250	
KVLC Little Rock, Ark.	10000		KIPA Hilo, Hawaii	1000		KSTT Davenport, Iowa	10000		KIBS Bishop, Calif.	250	
KWSD Water, Calif.	10000		WMBI Chicago, Ill.	50000		KVVO Tulsa, Okla.	50000		KXO El Centro, Calif.	250	
KLMO Longmont, Colo.	2500		WABE Charlotte, N.C.	50000		KPUC Ponce, P.R.	250		KDAC Ft. Bragg, Calif.	250	
WJSB Crestview, Fla.	10000		WBT Charlotte, N.C.	50000		WVVA Wheeling, W. Va.	50000		KGFI Los Angeles, Calif.	250	
VIVY Jacksonville, Fla.	10000		KEND Bend, Oreg.	5000					KPRL Paso Robles, Calif.	250	
WHBO Tampa, Fla.	2500		WNAW Norristown, Pa.	5000					KWGG Redding, Calif.	250	
WRMF Titusville, Fla.	5000		VJGU Caguas, P.R.	250					KWGO Stockton, Calif.	250	
WJAZ Albany, Ga.	10000		WHIM Providence, R.I.	10000					KEXO Grand Junction, Colo.	250	
WAUG Augusta, Ga.	10000								KLVC Leadville, Colo.	250	
WBEI Marietta, Ga.	10000		1120-267.7						KDZA Pueblo, Colo.	250	
KZIN Coeur D'Alene, Idaho	2500		WUST Bethesda, Md.	2500		1190-252.0			KGEK Sterling, Colo.	250	
WDZ Decatur, Ill.	10000		KMOX St. Louis, Mo.	50000		KEZY Anaheim, Calif.	1000		WINF Manchester, Conn.	250	
KNCO Garden City, Kans.	10000		WVOL Buffalo, N.Y.	10000		KNBA Vallejo, Calif.	2500		WGGG Gainesville, Fla.	250	
WZIP Covington, Ky.	10000		KCLE Cleburne, Tex.	2500		WOWO Ft. Wayne, Ind.	5000		WONN Lakeland, Fla.	250	
KLPL Lake Providence, La.	2500					WANN Annapolis, Md.	10000		WMAF Madison, Fla.	250	
KCJL Shreveport, La.	2500		1130-265.3			WLIB New York, N.Y.	10000		WSSB New Smyrna Bch., Fla.	250	
WQMR Silver Sprng., Md.	10000		CKWX Vancouver, B.C.	50000		KEX Portland, Oreg.	50000		WNVY Pensacola, Fla.	250	
WPAG Ann Arbor, Mich.	10000		CKSD San Diego, Calif.	5000		KLIF Dallas, Tex.	50000		WCNH Quincy, Fla.	250	
KOHL Pleasanton, Minn.	10000		KWKC Shreveport, La.	50000					WJNO W. Palm Beach, Fla.	250	
WCR Columbus, Miss.	10000		WCAR Detroit, Mich.	50000		1200-249.9			WBIJ Augusta, Ga.	250	
KSIS Sodaia, Mo.	10000		WDGY Minneapolis, Minn.	50000		WOAI San Antonio, Tex.	50000		WDLJ Dalton, Ga.	2500	
KREB Las Vegas, Nev.	5000		WNEW New York, N.Y.	50000					WXM Dublin, Ga.	2500	
WBNC Conway, N.H.	10000								WFOF Marietta, Ga.	250	
WSEN Baldwinville, N.Y.	2500		1140-263.0						WSOK Savannah, Ga.	250	
WSTN Massena, N.Y.	10000		KKAL Calgary, Alta.	10000		1210-247.8			WAYX Waycross, Ga.	250	
WMGM New York, N.Y.	50000		CRXL Stockholm, Calif.	5000		WCNT Centralia, Ill.	10000		KBAR Bury, Idaho	250	
WBTL Farmville, N.C.	2500		WJIE Miami, Fla.	10000		WKNX Saginaw, Mich.	10000		KORT Grangeville, Idaho	250	
WFOF Franklin, N.C.	5000		KGEM Boise, Idaho	10000		WADE Wadesboro, N.C.	2500		KRXK Rexburg, Idaho	250	
WLON Lincolnton, N.C.	10000		WSPK Pekin, Ill.	10000		WAVI Dayton, Ohio	2500		WJEB Bismington, Ill.	250	
WGGP Sanford, N.C.	10000		KLPR Oklahoma City, Okla.	10000		WCAU Philadelphia, Pa.	50000		WQUA Moline, Mo.	250	
KCCO Lawton, Okla.	2500		WITA San Juan, P.R.	500					WHCO Sparta, Ill.	250	
KFMJ Tulsa, Okla.	10000		KSOU Sioux Falls, S. Dak.	10000		1220-245.8			WJOB Hammond, Ind.	250	
KUBE Pendleton, Oreg.	10000		KORC Mineral Wells, Tex.	2500		CJOC Lethbridge, Alta.	10000		WSAL Logansport, Ind.	250	
KEED Springfield, Oreg.	10000		WVRA Richmond, Va.	50000		CKDA Victoria, B.C.	10000		WTCJ Tell City, Ind.	250	
WBUT Butler, Pa.	10000					CJRL Kenora, Ont.	1000		WBOW Terre Haute, Ind.	250	
WLYC Williamsport, Pa.	10000		1150-260.7			CKEC New Glasgow, N.S.	250		WHIR Marshalltown, Iowa	250	
WSMT Sparta, Tenn.	10000		CKSA Lloydminster, Alta.	1000		CKCW Moncton, N.B.	10000		WHOP Hopkinsville, Ky.	250	
KLEN Killen, Tex.	2500		CHSJ Saint John, N.B.	5000		CJSS Cornwall, Ont.	10000		WMLF Pineville, Ky.	250	
KWLD Liberty, Tex.	2500		CXKO Hamilton, Ont.	5000		CKSM Shawinigan, Quebec	10000		KLIC Monroe, La.	250	
WGAT Gate City, Va.	2500		CKXK Brandon, Man.	5000		WEPN Butler, Ala.	10000		WJBW New Orleans, La.	250	
WBRG Lynchburg, Va.	10000		CKTR Three Rivers, Que.	10000		KVSA McGehee, Ark.	10000		KSLO Opelousas, La.	250	
WCMS Norfolk, Va.	10000		WBCA Bay Minette, Ala.	10000		KIBE Palo Alto, Calif.	10000		WJEB Batesville, Mo.	250	
KNBX Kirkland, Wash.	10000		WGEA Geneva, Ala.	10000		KFCSE Denver, Colo.	10000		WCUM Cumberland, Md.	250	
WCEF Parkersburg, W. Va.	10000		WIRD Tuscaloosa, Ala.	5000		WTTT Arlington, Fla.	10000		WMNB No. Adams, Mass.	250	
WECL Eau Claire, Wis.	10000		KCKY Coolidge, Ariz.	1000		WKBX Kissimmee, Fla.	2500		WESX Salem, Mass.	250	
WLIP Kenosha, Wis.	2500		KXLR No. Little Rock, Ark.	5000		WFEK Miami, Fla.	2500		WNEB Worcester, Mass.	250	
KWIV Douglas, Wyo.	2500		KFSG Los Angeles, Calif.	2500		WPLK Camilla, Ga.	10000		WJEF Grand Rapids, Mich.	500	
			KRKB Los Angeles, Calif.	5000		WFSF Thomaston, Ga.	10000		WKIB Iron River, Mich.	250	
1060-282.8			KJAX Santa Rosa, Calif.	10000		WLPO LaSalle, Ill.	10000		WMPC Capeer, Mich.	250	
CFCN Calgary, Alta.	10000		KGMC Englewood, Colo.	10000		WKRK Rockmart, Ga.	10000		WSOC Sit. St. Louis, Mo.	250	
CJLR Quebec, Que.	5000		KCNX Middletown, Conn.	5000		WLSM Salem, Ind.	10000		WSTR Sturgis, Mich.	250	
KPAY Chico, Calif.	10000		WDEL Wilmington, Del.	5000		KJAN Atlantic, Iowa	2500		WKLK Cloquet, Minn.	250	
WNOE New Orleans, La.	50000		WONB Daytona Bch., Fla.	10000		KOFO Ottawa, Kans.	2500		KYSM Mankato, Minn.	250	
WHFB Benton Harbor, Mich.	10000		WTMP Tampa, Fla.	50000		WFKN Franklin, Ky.	2500		KTRF Right Riv. Falls, Minn.	250	
WMAP Monroe, N.C.	2500		WJPM Fort Valley, Ga.	10000		WLBK Bossier City, La.	2500		KWNO Winona, Minn.	250	
WRCW Canton, Ohio	10000		KANI Oahu, Hawaii	10000		WSME Sanford, Maine	2500		WCMA Corinth, Miss.	250	
WRCV Philadelphia, Pa.	50000		WKWY Des Moines, Iowa	1000		WBCH Hastings, Mich.	2500		WSSO Starkville, Miss.	250	
			KSAL Salina, Kans.	5000		WAVN Stillwater, Minn.	10000		WAZF Yazoo City, Miss.	250	
1070-280.2			WLMC Mt. Sterling, Ky.	5000		WMDC Hazlehurst, Miss.	2500		KODE Joplin, Mo.	250	
CBA Sackville, N.B.	50000		WJOB Baton Rouge, La.	5000		KBHM Branson, Mo.	10000		KLWT Lebanon, Mo.	250	
CHOK Sarnia, Ont.	5000		WJCH Lewiston, Maine	5000		KGMO Cape Girardeau, Mo.	2500		KNCM Moberly, Mo.	250	
WAPI Birmingham, Ala.	50000		WCOP Baton Rouge, La.	10000		KLBW Union, Mo.	10000		KANA Anacanda, Mont.	250	
WAGL Los Angeles, Calif.	5000		WCEN Mt. Pleasant, Mich.	10000		KGKE Keene, N.H.	10000		KBMJ Bozeman, Mont.	250	
WVCG Coral Gables, Fla.	10000		KASM Albany, Minn.	10000		WJMK N. Syracuse, N.Y.	10000		KXLO Lewiston, Mont.	250	
WIBC Indianapolis, Ind.	50000		WXTN Lexington, Miss.	5000		WKMT Kings Mtn., N.C.	10000		KLCB Libby, Mont.	100	
			KRMS Osage Beach, Mo.	10000		WREV Reidsville, N.C.	2500		KTNC Falls City, Nebr.	250	
									KHAS Hastings, Nebr.	250	
									KELY Ely, Nev.	250	
									KAS Las Vegas, Nev.	250	
									KDOR Reno, Nev.	250	
									WMOU Berlin, N.H.	250	

Ac.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	
1290—232.4																
CFAM	Alfonsa, Man.	5000	WJRH	Richmond Hill, Ont.	1000	WEBC	Milton, Fla.	5000	WAGN	Menominee, Mich.	250					
CKSL	London, Ont.	5000	WHEP	Foley, Ala.	1000	WMEN	Tallahassee, Fla.	5000	WMBN	Potosky, Mich.	250					
WTHG	Jackson, Ala.	1000	WJAM	Marion, Ala.	5000	WMIT	Dublin, Ga.	5000	WEXL	Royal Oak, Mich.	250					
WMLS	Sylacauga, Ala.	1000	KBWZ	5000		WEAW	Easton, Ill.	5000	KDLR	Detroit Lakes, Minn.	250					
KEOS	Flagstaff, Ariz.	1000	KBOK	Malvern, Ark.	1000	WRAM	Monmouth, Ill.	1000	WEVE	Elmfield, Minn.	250					
KCBU	Tucson, Ariz.	1000	KBWR	Oakland, Calif.	1000	WRRR	Rockford, Ill.	1000	KROC	Rochester, Minn.	250					
KDMS	El Dorado, Ark.	5000	KTKR	Taft, Calif.	5000	WJPS	Evansville, Ind.	5000	KWLM	Willmar, Minn.	250					
KUDA	Silom Sprgs., Ark.	5000	KFKA	Greeley, Colo.	1000	KWWL	Waterloo, Iowa	5000	WJMB	Brookhaven, Miss.	250					
WCHS	Chico, Calif.	5000	WICH	Norwich, Conn.	1000	KFH	Wichita, Kans.	5000	WAML	Laurel, Miss.	250					
KPER	Gilroy, Calif.	5000	WOOD	Deland, Fla.	5000	WMOR	Morehead, Ky.	1000	KXMD	Meriden, Mo.	250					
KITO	San Bernardino, Calif.	5000	WUOZ	Waukegan, Fla.	5000	KVLA	Lafayette, La.	1000	KSEM	St. Louis, Mo.	250					
WCCE	Hartford, Conn.	5000	WBDO	Westboro, Ga.	5000	WASA	Salisbury, Md.	1000	KCKK	Springfield, Mo.	250					
WTUX	Wilmington, Del.	1000	WBWK	West Point, Ga.	1000	WCRB	Waltham, Mass.	5000	KCAP	Helena, Mont.	250					
WTMG	Ocala, Fla.	5000	KLIX	Twin Falls, Idaho	1000	WTRF	Flint, Mich.	1000	KPRK	Livingston, Mont.	250					
WSCM	Panama City Beach, Fla.	5000	WISH	Indianapolis, Ind.	5000	WLOL	Minneapolis, Minn.	5000	KATL	Miles City, Mont.	250					
			KOKX	Keokuk, Iowa	1000	WCCR	Conneaut, Miss.	5000	KQTE	Missoula, Mont.	250					
			WTTL	Madisonville, Ky.	5000	WJPR	Greenville, Miss.	1000	KFGT	Fremont, Nebr.	100					
			WDGO	Prestonsburg, Ky.	5000	WDAL	Meridian, Miss.	1000	KFWF	Leavenworth, Nebr.	250					
			KUZN	St. Louis, Mo.	1000	KKJL	Willow Springs, Mo.	5000	KSID	Sioux Falls, S.D.	250					
			WLOB	Portland, Maine	1000	KGAK	Galveston, Tex.	5000	KORK	Las Vegas, Nev.	250					
			WORC	Worcester, Mass.	5000	WEVD	New York, N.Y.	5000	KBT	Reno, Nev.	250					
			WKMH	Dearborn, Mich.	5000	WPWO	New York, N.Y.	5000	WDCR	Hanover, N.H.	250					
			KRBI	St. Peter, Minn.	1000	WBSO	Oswego, N.Y.	1000	WMID	Atlantic City, N.J.	250					
			WXXX	Hattiesburg, Miss.	1000	WHAZ	Troy, N.Y.	1000	KNDE	Aztec, N.M.	250					
			KFSB	Joplin, Mo.	5000	WFN	Findlay, Ohio	1000	KSIL	Silver City, N.Mex.	1000					
			KFCB	Grass Valley, Mont.	5000	KWOL	Wellston, Ohio	5000	WMBE	Bozeman, N.Y.	250					
			WLJK	Asbury Park, N.J.	250	KPOJ	Portland, Ore.	5000	WENT	Gloversville, N.Y.	250					
			WCAM	Camden, N.J.	250	KCSA	Spokane, Wash.	5000	WJOC	Jamestown, N.Y.	250					
			KACA	Albuquerque, N.M.	1000	WBLF	Bellefonte, Pa.	5000	WUSJ	Lockport, N.Y.	250					
			WVIP	Mt. Kisco, N.Y.	1000	WLCU	Erie, Pa.	5000	WMSA	Massena, N.Y.	250					
			WTLB	Utica, N.Y.	1000	WLAT	Conway, S.C.	5000	WALL	Middletown, N.Y.	250					
			WASV	Asheville, N.C.	5000	WFCB	Greenville, S.C.	5000	WIRY	Plattsburg, N.Y.	250					
			WKTC	Charlotte, N.C.	5000	WAEW	Grossville, Tenn.	1000	WIRI	Lebanon, N.Y.	250					
			WTRF	Clarkston, N.C.	5000	KPOJ	Portland, Ore.	5000	WTSB	Lumberton, N.C.	250					
			KNOX	Grand Forks, N.Dak.	5000	KML	Campton, Tex.	5000	WXXF	Oxford, N.C.	250					
			WFAH	Alliance, Ohio	1000	KSWA	Graham, Tex.	5000	WOOW	Washington, N.C.	250					
			KNPT	Newport, Oreg.	1000	KINE	Kingsville, Tex.	1000	WGNI	Wilmington, N.C.	250					
			WBFD	Bedford, Pa.	1000	KDDK	Tyler, Tex.	1000	WAIR	Winston-Salem, N.C.	250					
			WGSA	Ephrata, Pa.	1000	WBTM	Danville, Va.	5000	KGPF	Grafton, N.D.	250					
			WNAE	Warren, Pa.	5000	WESR	Tasley, Va.	1000	WACO	Concord, N.C.	250					
			WDBK	Kingsport, S.C.	5000	KFKF	Bellevue, Wash.	1000	WOUB	Athens, Ohio	250					
			WDDO	Chattanooga, Tenn.	5000	WETZ	New Mansville, Va.	1000	WIZE	Springfield, Ohio	250					
			WDXI	Jackson, Tenn.	5000	WHBL	Sheboygan, Wis.	1000	WSTV	Steuensville, Ohio	250					
			WBNT	Oneida, Tenn.	1000	KOVE	Lander, Wyo.	1000	KIHN	Hugo, Okla.	250					
			KZIP	Amarillo, Tex.	1000				KOCY	Okla. City, Okla.	250					
			WRR	Dallas, Tex.	5000	1340—223.7										
			KOYL	Odesa, Tex.	5000	CFGB	Goose Bay, Nfld.	250	WFBG	Altouna, Pa.	250					
			KUBA	San Antonio, Tex.	5000	CJAF	Cabano, Que.	250	WCVI	Connellsville, Pa.	250					
			WEEL	Fairfax, Va.	1000	CFSL	Weyburn, Sask.	250	WSAJ	Grove City, Pa.	100					
			WGH	Newport News, Va.	1000	CFYK	Yellow Knife, N.W.T.	150	WKRR	Oil City, Pa.	250					
			KARY	Prosser, Wash.	1000	CHAD	Amos, Que.	250	WVMA	Philadelphia, Pa.	250					
			WIBA	Madison, Wis.	5000	CHLS	Longmont, Colo.	250	WRAW	Rose, Pa.	250					
			1320—227.1													
			CHQM	Vancouver, B.C.	1000	CHRD	Drummondville, Que.	250	WBRE	Wilkes-Barre, Pa.	250					
			CKEC	New Glasgow, N.S.	1000	CJQC	Quebec, Que.	250	WWPA	Williamsport, Pa.	250					
			CISO	Sorel, P.Q.	1000	CKAR	I Parry Sound, Ont.	250	WGRF	Aguaadilla, P.R.	250					
			CKKW	Kitchener, Ont.	1000	CKOX	Woodstock, Ont.	250	WOKE	Charleston, S.C.	250					
			WAGF	Dothan, Ala.	5000	WKUL	Cullman, Ala.	250	WRHI	Rock Hill, S.C.	250					
			WENN	Birmingham, Ala.	5000	WIOF	Florence, Ala.	250	WSSC	Sumter, S.C.	250					
			KBLU	Yuma, Ariz.	5000	WGCW	Salt Lake City, Utah	250	KJUV	Huron, S.D.	250					
			KWHN	Fort Smith, Ark.	1000	WFEZ	Sylacauga, Ala.	250	KRSD	Rapid City, S.Dak.	250					
			KRLW	Walnut Ridge, Ark.	1000	KIBH	Seward, Alaska	250	WBAC	Cleveland, Tenn.	250					
			KHSJ	Hemet, Calif.	5000	KIKO	Miami, Ariz.	250	WKRM	Columbia, Tenn.	250					
			KUDE	Oceanside, Calif.	5000	KNOG	Nogales, Ariz.	250	WGRV	Greenville, Tenn.	250					
			KGRA	Sacramento, Calif.	5000	KZOK	Prescott, Ariz.	250	WKGN	Knoxville, Tenn.	250					
			KAVI	Rocky Ford, Colo.	1000	KBTA	Batesville, Ark.	250	WHHM	Hamlet, Tenn.	250					
			WFRF	Waterbury, Conn.	1000	KGBS	Springdale, Ark.	250	WCDT	Winchester, Tenn.	250					
			WGBA	Hollywood, Fla.	5000	KENT	Arcata, Calif.	250	KWKC	Abilene, Tex.	250					
			WJHP	Jacksonville, Fla.	5000	KMAK	Fresno, Calif.	250	KAND	Coriscana, Tex.	250					
			WHIE	Griffin, Ga.	5000	KSFE	Needles, Calif.	250	KSET	El Paso, Tex.	250					
			WNEG	Toccoa, Ga.	1000	KATY	San Luis Obispo, Calif.	250	KDUB	Lubbock, Tex.	250					
			WKAN	Kankakee, Ill.	5000	KIST	Santa Barbara, Calif.	250	KRBA	Lurkin, Tex.	250					
			KMAQ	Maquoketa, Iowa	1000	KOMY	Watsonville, Calif.	250	KVIM	Channahon, Tex.	250					
			KLWN	Lawrence, Kans.	5000	KDEN	Denver, Colo.	250	KPDN	Pampa, Tex.	250					
			WNGO	Mayfield, Ky.	1000	KVRH	Salida, Colo.	250	KOLE	Port Arthur, Tex.	250					
			KVHL	Homer, La.	5000	WNHC	New Haven, Conn.	250	KTXL	San Angelo, Tex.	250					
			WICO	Salisbury, Md.	1000	WOOK	Washington, D.C.	250	KVIC	N. of Victoria, Tex.	250					
			WARA	Attleboro, Mass.	1000	WTAN	Clearwater, Fla.	250	WTWN	St. Johnsbury, Vt.	250					
			WLS	Lansing, Mich.	5000	WRDD	Daytona Beach, Fla.	250	WJMY	Covington, Va.	250					
			WDMJ	Marquette, Mich.	1000	WDSR	Lake City, Fla.	250	WJEA	Orange, Va.	250					
			WCPJ	Houston, Miss.	5000	WYTS	Marion, La.	250	KAGT	Anacortes, Wash.	250					
			KLXW	Clayton, Mo.	1000	WQXT	Palm Beach, Fla.	250	KPKW	Pasco, Wash.	250					
			KOLT	Scottsbluff, Neb.	5000	WSEB	Sebring, Fla.	250	KAPA	Raymond, Wash.	250					
			WWHG	Hornell, N.Y.	5000	WNSM	Valparaiso-Niceville, Fla.	250	KMEL	Wenatchee, Wash.	5000					
			WAGY	Forest City, N.C.	5000	WBAU	Athens, Ga.	250	WHAR	Clarksburg, W.Va.	250					
			WCOG	Greensboro, N.C.	5000	WAKI	Atlanta, Ga.	250	WEPH	Weymouth, W.Va.	250					
			KQDY	Minot, N.Dak.	1000	WGAA	Cedarhurst, Ga.	250	WMON	Montgomery, W.Va.	250					
			WQDK	Wapakoneta, Ohio	1000	WOKS	Columbus, Ga.	250	WVOE	Welch, W.Va.	250					
			KWOE	Clinton, Okla.	1000	WBBT	Lyons, Ga.	250	WLDE	Ladysmith, Wis.	250					
			WKAP	Allentown, Pa.	1000	WTIF	Tifton, Ga.	250	WRIT	Milwaukee, Wis.	250					
			WAMP	Pittsburgh, Pa.	5000	KPST	Prentiss, Idaho	250	WFHR	Wis. Rapids, Wis.	250					
			WSCR	Seranton, Pa.	1000	WSJO	Shoshone, Idaho	250	KOWB	Laramie, Wyo.	250					
			WRIO	Rio Piedras, P.R.	1000	WJPF	Herrin, Ill.	250	KWOR	Worland, Wyo.	250					
			WMSC	Columbia, S.C.	1000	WJOL	Joliet, Ill.	250	1350—222.1							
			KELF	St. Falls, S.Dak.	5000	WBIV	Bedford, Ind.	250	CHOV	Pembroke, Ont.	1000					
			WINT	Kingsport, Tenn.	5000	WTRC	Elkhart, Ind.	250	CJDC	Dawson Creek, B.C.	1000					
			WMNR	Manchester, Tenn.	1000	WLBC	Muncie, Ind.	250	CHGB	St. Anne de la Riviere, Que.	1000					
			KVMC	Colo. City, Tex.	1000	KROS	Clinton, Iowa	250	CKLB	Oshawa, Ont.	1000					
			KXYZ	Houston, Tex.	5000	WQIN	Quincy, Ill.	250	CKEN	Kentville, N.S.	1000					
			KCPX	Salt Lake City, Utah	5000	CKKN	Kansas City, Kans.	250	WELB	Elba, Ala.	1000					
			WLLY	Richmond, Va.	1000	KSEK	Pittsburg, Kans.	250	WGAD	Gadsden, Ala.	5000					
			KKRO	Aberdeen, Wash.	1000	WCMJ	Ashland, Ky.	250	KAAB	Hot Springs, Ark.	1000					
			KHIT	Kila, Ariz.	1000	WBNB	Murray, Ky.	250	KLYD	Bakersfield, Calif.	1000					
			WQMN	Superior, Wis.	1000	KVOB	Evansville, Ind.	250	CKCK	Concord, Calif.	500					
			1330—225.4													
			CBH	Halifax, N.S.	100	KRMD	Shreveport, La.	250	KGHF	Pueblo, Colo.	5000					
			WROS	Scottsboro, Ala.	1000	WFAU	Augusta, Maine	250	WNLK	Norwalk, Conn.	500					
			KMOP	Tucson, Ariz.	5000	WHOU	Houlton, Maine	250	WPCT	Putnam, Conn.	1000					
			KFAC	Los Angeles, Calif.	5000	WGAW	Gardner, Mass.	250	WDGF	Dade City, Fla.	1000					
			WARN	Pt. Pierce, Fla.	1000	WBRK	Pittsfield, Mass.	250	WRPB	Warner Robins, Ga.	1000					
			WYSE	Lakeland, Fla.	1000	WLEB	Bedford, Mass.	250	ERIC	Clinton, Idaho	500					
						WLAV	Grand Rav. Mich.	250	WAAP	Peoria, Ill.	1000					
						WCSS	Hillsdale, Mich.	100	WJBD	Salem, Ill.	5000					
						WMTA	Manistee, Mich.	250	WIOU	Kokomo, Ind.	5000					
1310—228.9																
CKOY</																

Re.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.
KBAL	San Saba, Tex.	500d	1440-208.2	CFOP	Courtenay, B.C.	1000	WMIQ	Iron Mtn., Mich.	250	WZEP	DeFuniak Springs, Fla.	1000d	WZEP	DeFuniak Springs, Fla.	1000d
KNAL	Victoria, Tex.	500		WHYH	Montgomery, Ala.	1000	WIBM	Jackson, Mich.	250		Florida				
WRIS	Roanoke, Va.	5000d		KPOK	Scottsdale, Ariz.	5000d	WKLA	Ludington, Mich.	250	WMBR	Jacksonville, Fla.	5000	WDMF	Butford, Ga.	1000
WKBH	LaCrosse, Wis.	5000d		KOKY	Little Rock, Ark.	5000d	WKAT	Port Huron, Mich.	250	WMBT	Butford, Ga.	1000	WKAM	Goshen, Ind.	1000d
KWYO	Sheridan, Wyo.	1000		KVON	Napa, Calif.	500	KBUN	Benidji, Minn.	250	WMOH	North Vernon, Ind.	500	WMOH	North Vernon, Ind.	500
1420-211.1															
CKPT	Peterborough, Ont.	1000		KPRO	Riverside, Calif.	1000	KBUM	Breckenridge, Minn.	250	KSO	Des Moines, Iowa	5000	KCRB	Chanute, Kans.	1000d
CJMT	Cascotimi, Que.	1000		KCOY	Santa Maria, Calif.	1000	WELY	Ely, Minn.	250	WRVK	Mt. Vernon, Ky.	5000	WVRL	Baton Rouge, La.	5000
CKOM	Saskatoon, Sask.	5000		WBIS	Bristol, Conn.	5000	KFAM	St. Cloud, Minn.	250	KBESF	Springhill, La.	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Aurora, Ill.	1000d		WABR	Winter Park, Fla.	5000	WROX	Clarkdale, Miss.	250	WVRL	Springhill, La.	1000d	WVRL	Baton Rouge, La.	5000
KHFS	Pacha Vista, Ariz.	1000d		WAGB	Bremerton, Wash.	5000	WJXX	Columbia, Miss.	250	WBRN	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KPOC	Pocahontas, Ark.	1000d		WIGB	Brunswick, Ga.	5000	WOKK	Meridian, Miss.	1000	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KSTN	Stockton, Calif.	1000		WRAN	Ana, Ill.	5000	WNAT	Natchez, Miss.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WLIS	Old Saybrook, Conn.	1000		WPRS	Paris, Ill.	5000	WROB	West Point, Miss.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WBRD	Bradenton, Fla.	1000		WGBM	Quincy, Ill.	1000	WMBH	Joplin, Mo.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WDBF	Delray Beach, Fla.	5000		WROK	Rockford, Ill.	1000	KIRX	Kirksville, Mo.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WSTN	St. Augustine, Fla.	1000d		WPGW	Portland, Ind.	5000	KOKA	Warrensburg, Mo.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Avondale Estates, Ga.	5000		KOHE	Shenandoah, Iowa	5000	KKWM	Portland, Me.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Columbus, Ga.	5000		WCHT	Topeka, Kans.	5000	KXKL	Bozeman, Mont.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WLET	Tecoma, Ga.	5000d		WLLP	Paris, Ky.	1000d	KUDI	Great Falls, Mont.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WINI	Murphyboro, Ill.	1000		WEZZ	Williamsburg, Ky.	5000	KXLL	Missoula, Mont.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WIMS	Michigan City, Ind.	1000		KMLB	Monroe, La.	5000	KVCK	Wolf Point, Mont.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WOC	Davenport, Iowa	5000		WJAB	Westbrook, Me.	5000d	KWBE	Beatrice, Neb.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KJCK	Junction City, Kans.	1000		WAAB	Worcester, Mass.	5000d	KNSF	Chico, Neb.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WTCR	Ashland, Ky.	5000d		WBGM	Bay City, Mich.	1000	KONE	Kenosha, Wisc.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Avondale, Pa.	5000		KEVE	Golden Valley, Minn.	5000	WKXL	Concord, N.H.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Owensboro, Ky.	1000		WMVB	Millville, N.J.	1000d	WFGP	Atlantic City, N.J.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KPEL	Lafayette, La.	1000		WBAW	Babylon, N.Y.	5000	WCTC	New Brunswick, N.J.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WBSM	New Bedford, Mass.	1000		WJLL	Niagara Falls, N.Y.	1000	KLOS	Albuquerque, N.Mex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WBEK	Pittsfield, Mass.	1000		WBLA	Elizabethtown, N.C.	1000	KWBE	Clayton, N.Mex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WAMM	Flint, Mich.	5000		WBUY	Lexington, N.C.	5000d	KENB	El Paso, N.Mex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KTOE	Mankato, Minn.	5000		KILO	Grand Forks, N.D.	1000	WHDL	Allegany, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Oxford, Miss.	5000		WHH	Warren, Ohio	5000	WCLI	Corning, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WBP	Richfield, Miss.	5000		KMED	Medford, Oreg.	5000	WVSC	Glen Falls, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KBTN	Neosho, Mo.	5000		KODL	The Dalles, Oreg.	1000	WHDL	Olean, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KOOO	Omaha, Nebr.	5000		WCDL	Carbondale, Pa.	5000d	WKIP	Poughkeepsie, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WALY	Herkimer, N.Y.	1000d		WGBE	Red Lion, Pa.	1000d	WKAL	Rome, N.Y.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WACK	Newark, N.Y.	5000		WQOK	Greenville, S.C.	5000	WATC	Boone, N.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WLNA	Peekskill, N.Y.	1000d		WZYX	Cowan, Tenn.	1000d	WGNC	Gastonia, N.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WMYN	Mayodan, N.C.	500		WHDH	McKenzie, Tenn.	5000	WVHV	Henderson, N.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	St. Gaston, N.C.	500		KEDA	Amherst, Tex.	5000	WHKP	Hendersonville, N.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVOT	Wilson, N.C.	1000		KEYS	Corpus Christi, Tex.	1000	WHIT	New Bern, N.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WHK	Cleveland, Ohio	1000		KDNT	Denton, Tex.	1000	WJER	Dover, Ohio	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KTJS	Hobart, Okla.	5000d		KETX	Livingston, Tex.	1000d	WMOH	Hamilton, Ohio	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KYNG	Coos Bay, Oreg.	1000d		WKLV	Blackstone, Va.	5000d	WLEO	Sumsky, Ohio	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WCOJ	Coatesville, Pa.	1000d		WHIS	Bluefield, W.Va.	5000	KHWH	Atkus, Okla.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WCED	DoBois, Pa.	5000		WVJR	Morgantown, W.Va.	5000	KGFF	Shawnee, Okla.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Poncha, Pa.	1000		WVJR	Morgantown, W.Va.	5000	KSIW	Woodward, Okla.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WCRE	Cherato, S.C.	1000		WJRG	Green Bay, Wis.	5000	KWRO	Couville, Oreg.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KABR	Aberdeen, S.D.	5000					KRUE	Eugene, Oreg.	1000	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WEMB	Erwin, Tenn.	1000d		1450-206.8			WFLW	Klamath Falls, Oreg.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WKSR	Pulaski, Tenn.	1000		CBG	Gander, Nfld.	250	KLBM	Klamath Falls, Oreg.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KFYN	Bonham, Tex.	250d		CFAB	Windsor, N.S.	250	KBPS	Portland, Oreg.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KTRE	Lufkin, Tex.	1000		CFJR	Brookville, Ont.	1000	WLEU	Erie, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KGNB	New Braunfels, Tex.	1000d		CHEF	Granby, P.Q.	1000	WGAT	Gettysburg, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KPEP	San Angelo, Tex.	1000d		CJOY	Guelph, Ont.	250	WDAD	Indiana, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WWSR	St. Albans, Vt.	5000		WDNG	Guelph, Ont.	250	WPAM	Pottsville, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WDDY	Gloucester, Va.	1000d		WYAM	Bessemer, Ala.	250	WVMT	St. Williamsport, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WKCW	Warrenton, Va.	5000d		WDIG	Dothan, Ala.	250	WVMT	St. Williamsport, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KICI	Chehalis, Wash.	5000d		WFUN	Huntsville, Ala.	250	WJPA	Washington, Pa.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KUJ	Walla Walla, Wash.	5000		WFLAY	Muscle Shoals City, Ala.	250	WNEL	Caguas, P.R.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WPLY	Plymouth, Wis.	5000		KLAM	Cordova, Alaska	250	WWRI	W. Warwick, R.I.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
1430-209.7															
CKFH	Toronto, Ont.	5000		KALD	Douglas, Ariz.	250	WQSN	Charleston, S.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WFHK	Pell City, Ala.	1000d		KENA	Mena, Ark.	250	WCBS	Greenwood, S.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KHBM	Monticello, Ark.	1000d		KYOR	Blythe, Calif.	250	WVBY	Myrtle Beach, S.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KAMP	El Centro, Calif.	1000d		KOWN	Escondido, Calif.	250	WHSG	Hartsville, S.C.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KARM	Fresno, Calif.	5000		KPAL	Palm Springs, Calif.	250	KBFS	Belle Fourche, S. Dak.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Indianapolis, Ind.	1000d		KTIP	Porterville, Calif.	250	KYNT	Yankton, S.Dak.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KOSI	Aurora, Colo.	5000		KSAN	San Francisco, Calif.	250	WLAR	Athens, Tenn.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WDSB	Homestead, Fla.	5000		KROG	Sonora, Calif.	250	WOGA	Chattanooga, Tenn.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WLAK	Lakeland, Fla.	5000		KVEN	Ventura, Calif.	250	WDSG	Dyersburg, Tenn.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WPCF	Panama City, Fla.	5000		KAGR	Yuba City, Calif.	250	WLAF	LaFollette, Tenn.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Covington, Ga.	1000d		KYOB	Alamosa, Colo.	250	WRCS	Brattleboro, Tenn.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WRCD	Dalton, Ga.	5000		KYOB	Greely, Colo.	250	KRIC	Beaumont, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Tifton, Ga.	5000d		WVAB	Waco, Tex.	250	KVEN	Carizzo Sprgs., Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WCMY	Waco, Tex.	5000		WILM	Wilmington, Del.	250	KCTI	Gonzales, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WIRE	Indianapolis, Ind.	5000		WOL	Washington, D.C.	250	KMBL	Junction, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KASI	Ames, Iowa	1000d		WVJB	Brooksville, Fla.	250	KCYL	Lampasas, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KMRC	Morgan City, La.	1000		WMFJ	Daytona Beach, Fla.	250	KMHT	Marshall, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WNAV	Annapolis, Md.	1000		WVRL	Daytona Beach, Fla.	250	KCMR	Marshall, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WHIL	Medford, Mass.	5000d		WVRL	Daytona Beach, Fla.	250	KNEP	Palentine, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WION	Ionis, Mich.	5000		WVRL	Daytona Beach, Fla.	250	KSNY	Snyder, Tex.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WBRB	Mt. Clemens, Mich.	5000		WVRL	Daytona Beach, Fla.	250	KURA	Moab, Utah	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WVRL	Laurel, Miss.	5000d		WVRL	Daytona Beach, Fla.	250	KEYV	Provo, Utah	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WIL	St. Louis, Mo.	5000		WVRL	Daytona Beach, Fla.	250	KDXU	St. George, Utah	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
KRGI	Grand Island, Nebr.	1000		WVRL	Daytona Beach, Fla.	250	WVRL	Barre, Vt.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WNJR	Newark, N.J.	5000		WVRL	Daytona Beach, Fla.	250	WVRL	Brattleboro, Vt.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WENE	Endicott, N.Y.	5000		WVRL	Daytona Beach, Fla.	250	WVRL	Front Royal, Va.	250	WVRL	Big Spring, Texas	1000d	WVRL	Baton Rouge, La.	5000
WMNC	Morgantown, N.C.	5000		WVRL	Daytona Beach, Fla.	250	WVRL	Lexington							

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
KLEE	Ottumwa, Iowa	500d	KTTR	Rolla, Mo.	250	KGBT	Harlingen, Tex.	5000d	WYTI	Rocky Mount, Va.	1000d
KBKC	Mission, Kans.	1000	KDRO	Sedalia, Mo.	250				WEER	Warrenton, W. Va.	500d
KLEO	Wichita, Kans.	5000	KBOW	Butte, Mont.	250	1540-195.0					
WKOA	Hogkinville, Ky.	1000d	KBOH	Omaha, Nebr.	250	ZNS	Nassau, B.W.I.	5000	WAPL	Appleton, Wis.	1000d
WNKY	Neon, Ky.	1000d	WDBB	Atlantic City, N.J.	250	KPOL	Los Angeles, Calif.	1000d	1580-189.2		
WTLO	Somersett, Ky.	1000d	KRSN	Los Alamos, N. Mex.	250	WSMI	Litchfield, Ill.	1000d	CBJ	Chicoutimi, Que.	1000d
KJOE	Shreveport, La.	1000d	KRTN	Raton, N. Mex.	250	WBNL	Boonville, Ind.	250d	WJHB	Talladega, Ala.	1000d
WSAR	Fall River, Mass.	5000	WCSS	Amsterdam, N.Y.	250	WLOI	LaPorte, Ind.	250d	KPCA	Marked Tree, Ark.	250d
WMAX	Grand Rapids, Michigan	1000d	WBTA	Batavia, N.Y.	250	KXEL	Waterloo, Iowa	5000d	KDFE	Van Buren, Ark.	1000d
WIOS	Tawas City, Mich.	1000d	WKNY	Kingston, N.Y.	250	KNEX	McPherson, Kans.	250d	KWIP	Mered, Calif.	500d
KAUS	Austin, Tenn.	1000	WICY	Malone, N.Y.	250	KLKC	Parsons, Kans.	250d	KDAY	Santa Monica, Cal.	5000d
KGCX	Sidney, Mont.	5000	WDLG	Longview, Tex.	250	WDON	Wheaton, Md.	250d	KPIK	Colorado Sprags., Colo.	5000d
KLMS	Lincoln, Nebr.	1000	WOLF	Syracuse, N.Y.	250	WPTN	Albany, N.Y.	5000d	WWIL	Ft. Lauderdale, Fla.	1000
KWEW	Hobbs, N. Mex.	5000	WSSB	Durham, N.C.	250	WFM	Elkin, N.C.	250d	WGRC	Green Cove Springs, Florida	500d
WLEA	Hornell, N.Y.	1000d	WFLB	Fayetteville, N.C.	250	WABQ	Cleveland, Ohio	1000d	WIOK	Mount Dora, Fla.	1000d
WHOM	New York, N.Y.	5000	WLOE	Leaksville, N.C.	250	WIMJ	Philadelphia, Pa.	5000d	WRFB	Tallahassee, Fla.	5000d
WREM	Rensselaer, N.Y.	1000d	WRNB	New Bern, N.C.	250	WPTS	Pittsburg, Pa.	1000d	WCLS	Columbus, Ga.	1000d
WKOC	Charlotte, N.C.	1000d	WRMT	Rocky Mount, N.C.	250	WPME	Punxsutawney, Pa.	1000d	WLBA	Gainesville, Ga.	5000d
WYRN	Louisburg, N.C.	5000	KNDG	Gettinsger, N. Dak.	250	WADK	Newport, R.I.	1000d	WDQN	DuQuoin, Ill.	250d
WMSJ	Sylva, N.C.	5000d	KQVC	Valley City, N. Dak.	250	KCUK	Ft. Worth, Tex.	1000d	WBBA	Pittsfield, Ill.	250d
WHBC	Canton, Ohio	5000	WBEX	Chillicothe, Ohio	250	KGBG	Galveston, Tex.	500d	WKID	Urbana, Ill.	250d
WCIN	Cincinnati, Ohio	1000d	WJMO	Cleveland Hgts., Ohio	250	WTKM	Hartford, Wis.	500d	WCNB	Connersville, Ind.	250d
WTRA	Latrobe, Pa.	500d	WOHI	E. Liverpool, Ohio	250	1550-193.5					
WDAS	Philadelphia, Pa.	5000	WMOA	Marietta, Ohio	250	CBE	Windsor, Ont.	1000d	WJVA	South Bend, Ind.	1000d
WISL	Shamokin, Pa.	1000	WMRN	Marion, Ohio	250	WAAY	Huntsville, Ala.	5000	WAMW	Washington, Ind.	250d
WMBL	Memphis, Tenn.	5000d	KWRW	Guthrie, Okla.	100	KOBY	San Fran., Calif.	1000d	KCHA	Charles City, Iowa	500d
KBOB	Dallas, Tex.	5000	KBIX	Muskogee, Okla.	250	KENT	Shreveport, La.	1000d	KDSD	Denison, Iowa	500d
KLVL	Pasadena, Tex.	1000	KKBR	Baker, Oreg.	250	KRES	St. Joseph, Mo.	5000	WAXU	Georgetown, Ky.	250d
WCFR	Springfield, Vt.	1000d	KRNR	Roseburg, Oreg.	250	WLOA	Bradford, Pa.	1000d	WMTL	Leitchfield, Ky.	250d
WBBL	Richmond, Va.	5000	KBZY	Salem, Oreg.	250	WBSC	Bennettsville, S.C.	1000d	WPKY	Princeton, Ky.	250d
WLEE	Richmond, Va.	5000	WESS	Bradford, Pa.	250	1560-192.3					
WBLU	Salem, Va.	5000d	WAZL	Hazleton, Pa.	250	CFRS	Simcoe, Ont.	250d	KLOU	Lake Charles, La.	1000d
KVAN	Camas, Wash.	1000d	WARD	Johnstown, Pa.	250	KPMC	Bakersfield, Calif.	1000d	WPGC	Bradbury Hgts., Md.	1000d
KWGG	Lakewood, Wash.	1000d	WGLA	Lawrence, Mo.	250	WBSY	Canton, Ill.	250d	WOWE	Allegan, Mich.	250d
WISM	Madison, Wis.	1000	WBCB	Levittown, Pa.	250	KSWI	Council Bluffs, Iowa	500d	KDOM	Windom, Minn.	250d
1490-201.2			WMRF	Leviston, Pa.	250	WDXR	Paducah, Ky.	1000	WAMY	Amory, Miss.	5000d
CFRC	Kingston, Ont.	100	WMGW	Meadeville, Pa.	250	WQXR	New York, N.Y.	5000d	WGLC	Centerville, Miss.	250d
KCCR	Kitchener, Ont.	250	WNBT	Wellsboro, Pa.	250	WTNS	Coshocton, Ohio	1000d	WESY	Leland, Miss.	1000
CKBM	Montaguay, Que.	250	WMDJ	Fajardo, P.R.	250	WTOE	Toledo, Ohio	1000d	WPMP	Paseagoula, Miss.	1000d
WANA	Annisston, Ala.	250	WGDG	Chester, S.C.	250	KWCO	Chickasha, Okla.	1000	KBIA	Columbia, Mo.	250d
WAIC	Decatur, Ala.	250	WMRB	Greenville, S.C.	250	KHBR	Hillsboro, Tex.	250d	KNIM	Marville, Mo.	250d
WRLD	Sanetta, Ala.	250	KORN	Mitchell, S. Dak.	250	1570-191.1					
WHBB	Selma, Ala.	250	WOPI	Bristol, Tenn.	250	CHUB	Nanaimo, B.C.	1000d	WGRV	Washington, N.J.	500d
KYCA	Frescott, Ariz.	250	WDXB	Chattanooga, Tenn.	250	CFRY	Portage la Prairie, Manitoba	250d	KZAK	Albamar, N.C.	250d
KAIR	Tuscon, Ariz.	250	WJIM	Lewisburg, Tenn.	250	CBI	Sidney, N.S.	1000	WYKO	Columbus, Ohio	1000d
KXAR	Hope, Ark.	250	WDLX	Lexington, Tenn.	250	CFOR	Orillia, Ont.	1000d	KLTR	Blackwell, Okla.	250d
KTLO	Mtn. Home, Ark.	250	KNOW	Austin, Tex.	250	WCLR	Okeona, Ala.	250d	WGOY	Columbia, Pa.	500d
KDRS	Paragould, Ark.	250	KIBL	Beville, Tex.	250	WRWJ	Selma, Ala.	1000d	WANB	Waynesburg, Pa.	250d
KOTN	Pine Bluff, Ark.	250	KHUS	Borger, Tex.	250	KBRI	Brinkley, Ark.	250d	WBPD	Orangeburg, S.C.	1000d
KKRJ	Russellville, Ark.	250	KNEL	Brady, Tex.	250	KBJT	Fordyce, Ark.	250d	WYCL	York, S.C.	250d
KMAP	Bakersfield, Calif.	250	KSAM	Huntsville, Tex.	250	KRKC	King City, Calif.	250d	WLJI	Shelbyville, Tenn.	1000d
KPAS	Banning, Calif.	250	KVOZ	Laredo, Tex.	250	KCVR	Lodi, Calif.	250d	KGAF	Gainesville, Tex.	250d
BLBA	Burbank, Calif.	250	KZZN	Littlefield, Tex.	250	KACE	Riverside, Calif.	250d	KIRT	Mission, Tex.	1000d
KICO	Calexico, Calif.	250	KPTL	Paris, Tex.	250	KLOV	Loveland, Colo.	250d	KTLU	Cusk, Tex.	250d
KOWL	Lake Tahoe, Calif.	250	KGKB	Garland, Tex.	250	WTWB	Auburndale, Fla.	1000d	KWED	Seguin, Tex.	1000d
KAFP	Petaluma, Calif.	250	KVVG	Vernon, Tex.	250	WPAP	Fernandina Beach, Florida	1000d	KEVA	Shamrock, Tex.	250d
KBLF	Red Bluff, Calif.	250	WIKE	Newport, Vt.	250	WJDE	Ward Ridge, Fla.	250d	WILA	Danville, Va.	1000d
KYCA	Santa Barbara, Calif.	250	WVCA	Culpeper, Va.	250	WEAS	College Park, Ga.	1000d	WPUP	Pulaski, Va.	5000d
KSYC	Freka, Calif.	250	WVEC	Hampton, Va.	250	WGSB	Millen, Ga.	250d	WTTN	Watertown, Wis.	250d
KBOB	Boulder, Colo.	250	WYAB	Waynesboro, Va.	250	WKOK	Alton, Ill.	250d	1590-188.7		
KCMS	Manitou Sprags., Colo.	100	KBRG	Bremerton, Wash.	250	WFRF	Freeport, Ill.	1000d	WATM	Atmore, Ala.	5000d
KOLO	Stirling, Colo.	250	KLOG	Keokuk, Iowa	250	WBEE	Harvey, Ill.	1000d	WYNA	Tuscumbia, Ala.	5000d
WNLC	New London, Conn.	250	KENE	Tappenhiss, Wash.	250	WTAY	Robinson, Ill.	250d	KPBA	Pine Bluff, Ark.	1000d
WTOR	Torrington, Conn.	250	KTEL	Walla Walla, Wash.	250	WLOF	Frankfort, Ind.	250d	KLIV	San Jose, Calif.	1000
WTRL	Bradenton, Fla.	250	WHMS	Charleston, W. Va.	250	WAWK	Kendallville, Ind.	250d	KUDU	Ventura, Calif.	1000
WTRF	Deland, Fla.	250	WTCS	Fairmont, W. Va.	250	WOWI	New Albany, Ind.	1000d	WERY	Waterbury, Conn.	5000
WMET	Miami Beach, Fla.	250	WLOH	Princeton, W. Va.	250	KMCD	Fairfield, Iowa	250d	WILZ	St. Petersburg Beach, Fla.	1000d
WSRA	Milton, Fla.	250	WLOZ	Beloit, Wis.	250	KJFJ	Webster City, Iowa	250d	WELE	S. Daytona Bch., Fla.	1000d
WRGR	Starke, Fla.	250	WLOX	LaCrosse, Wis.	250	KWKS	Manlyville, Kans.	250d	WALB	Albany, Ga.	1000
WTTB	Verona Beach, Fla.	250	WIGM	Medford, Wis.	250	WKWS	Vaneburg, Ky.	250d	WLFA	Lafayette, Ga.	1000
WSIR	Winter Haven, Fla.	250	WOSH	Oskosh, Wis.	250	WABL	Amite, La.	500d	WNMP	Easton, Ill.	1000d
WMOG	Brunswick, Ga.	250	KIML	Gillette, Wyo.	250	KLLA	Leesville, La.	250d	WAIK	Galesburg, Ill.	5000d
WMRE	Cordale, Ga.	250	KRTR	Thermopolis, Wyo.	250	KMAR	Winnsboro, La.	500d	WGEE	Indianapolis, Ind.	5000d
WSFB	Quitman, Ga.	250	KGOS	Torrington, Wyo.	250	WAGE	Townsend, Md.	1000d	WPFO	Mt. Vernon, Ind.	500d
WSNT	Sandersville, Ga.	250	1500-199.9			WPEP	Taunton, Mass.	1000d	KWBG	Boone, Iowa	500d
WSYL	Sylvania, Ga.	250	CHUC	Port Hope, Ont.	1000	WDEW	Westfield, Mass.	1000d	KVGB	Great Bend, Kans.	5000
KTOH	Lihue, Hawaii	250	KXRX	San Jose, Calif.	1000	WMRP	Flint, Mich.	1000d	WLBK	Lebanon, Ky.	1000d
KGID	Caldwell, Idaho	250	WTOP	Washington, D.C.	5000d	KNDY	Manlyville, Kans.	250d	KEVL	White Castle, La.	1000d
WKRO	Calico, Ill.	250	WKIZ	Key West, Fla.	1000d	WKWS	Vaneburg, Ky.	250d	WVTV	Valdosta, Mich.	5000
WDAN	Danville, Ill.	250	WJBK	Detroit, Mich.	1000d	WABL	Amite, La.	500d	WDOG	Marine City, Mich.	1000d
WAMV	East St. Louis, Ill.	250	WSTP	St. Paul, Minn.	5000d	KLLA	Leesville, La.	250d	WOKJ	Jackson, Miss.	5000d
WOPA	Oak Park, Ill.	250	KTXO	Sherman, Tex.	250	KMAR	Winnsboro, La.	500d	KDEX	Dexter, Mo.	1000d
WKBV	Richmond, Ind.	250	1510-199.1			WAGE	Townsend, Md.	1000d	KPRS	Kansas City, Mo.	1000d
WNUD	South Bend, Ind.	250	CKOT	Tillsonburg, Ont.	1000d	WPEP	Taunton, Mass.	1000d	WEHH	Elmira Heights, N.Y.	500d
KBUR	Burlington, Iowa	250	KASK	Ontario, Calif.	1000	WDEW	Westfield, Mass.	1000d	WYNG	Warwick, R.I.	1000d
WBQU	Buque, Iowa	250	KTIM	San Rafael, Calif.	1000d	WMRP	Flint, Mich.	1000d	WABV	Abbeville, S.C.	1000d
WVTV	Waverly, Iowa	250	KMOR	Littleton, Colo.	1000d	WFRG	Grand Rapids, Mich.	1000d	WACA	Camden, S.C.	1000d
KTOP	Topeka, Kans.	250	WKAI	Macomb, Ill.	250d	WBAZ	Frederia, N.Y.	250d	KCCR	Pierre, S. Dak.	1000d
WKAY	Glasgow, Ky.	250	WMEX	Boston, Mass.	5000	WHOT	Campbell, Ohio	250d	WISO	Jonesboro, Tenn.	5000d
WOMI	Owensboro, Ky.	250	KANS	Independence, Mo.	1000d	WCLW	Wampsville, Ohio	250d	WDBL	Springfield, Tenn.	1000d
WSIP	Paintsville, Ky.	250	WLAG	Nashville, Tenn.	5000d	WPTW	Piqua, Ohio	1000d	KERC	Eastland, Tex.	500d
WIKG	Bogalusa, La.	250	KCTX	Childress, Tex.	250d	KZAT	Fredrick, Okla.	250d	KINT	El Paso, Tex.	1000d
KEUN	Euicue, La.	250	KSTV	Shreveport, Tex.	250d	KPRY	Okla.	1000d	WHITE'S RADIO LOG		
KAIL	Houma, La.	250	KGA	Spokane, Wash.	5000d	KGGG	Forest Grove, Oreg.	1000d	169		
KRUS	Ruston, La.	250	WAUX	Waukesha, Wis.	250d	KOHU	Hermiston, Oreg.	1000d			
WPOR	Portland, Maine	250	1520-197.4			WSBX	Doylstown, Pa.	1000d			
WTVL	Waterville, Maine	250	KACY	Port Hueneme, Calif.	250	WLAT	Latrobe, Pa.	1000d			
WARK	Hagerstown, Md.	250	WHOW	Clinton, Ill.	1000d	WMLP	Milton, Pa.	1000d			
WHAV	Haverhill, Mass.	250	KSIB	Creston, Iowa	1000d	WFGN	Gaffney, S.C.	1000d			
WMRC	Milford, Mass.	250	WKBW	Buffalo, N.Y.	5000d	WLSO	Loris, S.C.	1000d			
WABF	W. Springfield, Mass.	250	WFOY	Minneapolis, N.Y.	1000d	WHLP	Centerville, Tenn.	1000d			
WCBQ	Fremont, Mich.	250	KOMA	Okla. City, Okla.	5000d	WCLC	Cleveland, Tenn.	1000d			
WMDN	Midland, Mich.	250	KGOO	Oregon City, Oreg.	1000d	WTRB	Ripley, Tenn.	1000d			
KKRA	Alexandria, Minn.	250	WWWV	Rio Piedras, P.R.	250	KVLG	La Grange, Tex.	250d			
KOZY	Grand Rapids, Minn.	250	1530-196.1			KZOL	Muleshoe, Tex.	250d			
KLGR	Redwd. Falls, Minn.	100	KFKB	Sacramento, Calif.	5000d	KTER	Terrill, Tex.	250d			
WLOX	Biloxi, Miss.	250	WKCY	Cincinnati, Ohio	5000d	WKIC	Salt Lake City, Utah	500d			
WHOC	Chillicothe, Miss.	250				WSWV	Pennington Gap, Va.	1000d			
WTUP	Tupelo, Miss.	250									
WVIM	Vicksburg, Miss.	250									
KDMO	Carthage, Mo.	250									

Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.	Kc.	Wave Length	W.P.
KYOK	Houston, Tex.	5000	KLAK	Lakewood, Colo.	1000	KLVI	Vivian, La.	5000	KUSH	Cushing, Okla.	10000
KCBQ	Lubbock, Tex.	1000	WKTN	Duvern, B.C.	5000	WINX	Rockville, Md.	1000	KASH	Eugene, Oreg.	1000
KBUS	Mexia, Tex.	5000	WKTX	Atlantic Beach, Fla.	10000	WBOS	Brookline, Mass.	5000	WHOL	Elizabethtown, Pa.	5000
KDOD	Sinton, Tex.	10000	WKWF	Kay West, Fla.	500	WYTM	East Longmeadow, Mass.	50000	WFIS	Fountain Inn, S.C.	10000
WEZL	Richmond, Va.	50000	WHEW	Riviera Beach, Fla.	10000	WHRV	Ann Arbor, Mich.	1000	WGUS	N. Augusta, S.C.	500
KTIX	Seattle, Wash.	50000	WOKB	Winter Garden, Fla.	10000	WTRU	Muskegon, Mich.	5000	WHBT	Harriman, Tenn.	50000
WSWV	Platteville, Wis.	10000	WGKA	Atlanta, Ga.	10000	WKDL	Clarksdale, Miss.	10000	WKBJ	Milan, Tenn.	10000
WTRW	Two Rivers, Wis.	10000	WCGO	Chicago Hgts., Ill.	10000	KATZ	St. Louis, Mo.	5000	KBBB	Borger, Tex.	5000
KCHY	Cheyenne, Wyo.	10000	WBTO	Linton, Ind.	5000	KNTN	Trenton, Mo.	5000	KBOR	Brownsville, Tex.	1000
			WARU	Peru, Ind.	10000	KNGY	Nebraska City, Nebr.	5000	KWEL	Midland, Tex.	1000
			KLGA	Algonia, Iowa	50000	WONG	Oneida, N.Y.	10000	KCFH	Cuero, Tex.	5000
			KCRG	Cedar Rapids, Iowa	5000	WURL	Woodside, N.Y.	10000	KMAE	McKinney, Tex.	10000
			KMDO	Ft. Scott, Kans.	5000	WVIG	Charlotte, N.C.	10000	KOGT	Orange, Tex.	1000
			WNES	Central City, Ky.	5000	WIDU	Fayetteville, N.C.	10000	KBBC	Centerville, Utah	10000
			WSTL	Eminence, Ky.	5000	WFRS	Reidsville, N.C.	10000	WBOF	Virginia Beh., Va.	10000
			KFTV	Ferriday, La.	10000	WWSK	W. Jefferson, N.C.	10000	WHLL	Wheeling, W. Va.	50000
			KLFY	Golden Meadow, La.	10000	WBLV	Springfield, Ohio	10000	WCWC	Ripon, Wis.	50000
						WTFE	Tiffin, Ohio	5000			

U. S. and Canadian AM Stations by Location

Abbreviations: C.L., call letters; Kc., frequency in kilocycles; N.A., network affiliation—A: American Broadcasting Co., C: Columbia Broadcasting System, Inc.; M: Mutual Broadcasting System; N: National Broadcasting Co., Inc.

Location	C.L.	Kc.	N.A.	Location	C.L.	Kc.	N.A.	Location	C.L.	Kc.	N.A.
Abbeville, La.	KROF	960		Ambridge, Pa.	KZIP	1310		Atlantic City, N.J.	WFGP	1450	C
Abbeville, S.C.	WABY	1590		Ames, Iowa	WDBA	1460		Baytown, Tex.	KRGT	650	
Aberdeen, Md.	WAMD	970		Americus, Ga.	WDEC	1290		Beatrice, Nebr.	KWBE	1450	
Aberdeen, Miss.	WMND	1230		Ames, Iowa	WAGT	1340		Belgrade, Mont.	WBNF	1400	
Aberdeen, S.Dak.	KABR	1220			WOI	640		Beaufort, S.C.	WBEU	960	
	KSDN	930	A	Amherst, N.S.	CKDH	1400		Beaumont, Tex.	KFDM	560	A
Aberdeen, Wash.	KBKW	1450		Amite, La.	WABL	1570			KJET	1380	
	KXRO	1320	M	Amory, Miss.	WAMY	1580			KRIC	1450	
Abilene, Tex.	KRBC	1470	A	Amos, Que.	CHAD	1340			KTRM	990	
	KNIT	1280		Amsterdam, N.Y.	WCSS	1490			WBVE	1430	
Abingdon, Va.	KWKV	1340	M	Anaconda, Mont.	KANA	1230		Beaver Dam, Wis.	WBNF	1400	
Ada, Okla.	KADA	1230	A	Anaortes, Wash.	KAGT	940		Beaver Falls, Pa.	WJLS	560	C
Adel, Ga.	WAGG	1470		Anaheim, Calif.	KEZY	1190		Beckley, W. Va.	WWRN	620	N
Adrian, Mich.	WABJ	1490	A	Anchorage, Alaska	KBYR	1270			WBIV	1340	
Aguaadilla, P.R.	WABA	850			KFDQ	730	C-A		WBFD	1310	
	WGRF	1340			KENI	550	A-M-N		WBFT	1350	
Ahosekie, N.C.	WRSS	970		Andalusia, Ala.	WCTA	920	M		KIDL	1490	
Aiken, S.C.	WAKN	980		Anderson, Ind.	WCBC	1470	M		WJLS	560	C
Akron, Ohio	WAKR	1590	A		WHBU	1240	C		WOMP	120	M
	WADC	1350	C	Anderson, S.C.	WAIM	1230	C		WOHP	1390	
	WCUE	1150			WANS	1280	M		WBLF	1330	
	WHLO	640	M	Andrews, Tex.	KACT	1360			KBFS	1450	
Alamogordo, N.M.	KALG	1230	M	Annapolis, Md.	WANN	1190			WSWN	900	
	KRAC	1270			WABW	810			CJBQ	800	
Alamosa, Colo.	KGIW	1450	M	Ann Arbor, Mich.	WNAV	1430			WBIV	1260	
Albany, Ga.	WALB	1590	A		WHRV	1600	A		WBVE	1430	
	WGPC	1450	C	Anna, Ill.	WPAG	1050			KFUP	1070	M
	WJAZ	1050		Anniston, Ala.	WRAJ	1440			KVOS	790	A
Albany, Ky.	WANY	1390			WANA	1490		Bellingham-Ferndale, Wash.	KENY	930	
Albany, Minn.	KASM	1150			WDNG	1450	A	Belmont, N.C.	WCOC	1270	M-A
Albany, N.Y.	WKRC	1460	M		WHMA	1390		Beloit, Wis.	WBEL	1380	
	WPRR	1540	A	Anoka, Minn.	KANO	1470			WGEZ	1490	M
	WROW	590	C	Ansonia, Conn.	WAD	960			WJLS	560	C
Albany, Oreg.	KWIL	790	M	Antigo, Wis.	WATK	900	M	Belton, S.C.	WBZ	1330	
Albamar, N.C.	WABZ	1010		Antigonish, N.S.	CJFX	580		Belzoni, Miss.	WELZ	1460	
	WZKY	1580		Apello, Pa.	WAVL	910		Benidji, Minn.	KBUN	1450	M
Albert Lea, Minn.	KATE	1450	A	Apple Valley, Cal.	KAYR	960		Bend, Oreg.	KEND	1110	A
Albertville, Ala.	WAVU	630		Appleton, Wis.	WAPL	1570			KGRL	940	
Albion, Mich.	WALM	1260			WHBY	1230	M	Bennetsville, S.C.	WBSC	1550	M
Albuquerque, N.M.	KABQ	1350		Areadia, Fla.	WAPG	1480		Bennington, Vt.	WBTV	1370	
	KDEF	1150		Arcata, Calif.	KENL	1340		Benson, Minn.	KBBN	1370	
	KGGM	610	C	Ardmore, Okla.	KVSO	1240	A	Benton, Ark.	KBTA	690	
	KOB	1080	N	Arecibo, P.R.	WCNN	1280		Benton, Ky.	WBCL	1290	
	KQED	920	M		WMIA	1070		Benton Harbor, Mich.	WHFB	1060	
Alcoa, Tenn.	KARA	1310			WNK1	1230		Berkeley, Calif.	KRE	1400	
Alexander City, Ala.	KLOS	1550		Arkadelphia, Ark.	KYRC	1240	M	Berkeley Springs, W. Va.	WCST	1010	
	KHAM	1580	A	Ark. City, Kans.	KARL	1340		Berlin, N.H.	WBCT	1230	
	WEAG	1470		Arlington, Fla.	WTTT	1220		Berryville, Ark.	KTCN	1480	
	WRFS	1050		Arlington, Va.	WABL	780		Berwick, Pa.	WBXR	1280	
Alexandria, La.	KALE	580	A		WEAM	1390		Bessemer, Ala.	WYAM	1450	
	KDBS	1410		Artesia, N.M.	KSPV	990	M	Bethesda, Md.	WUST	1120	
	KSYL	970	N	Asbury Park, N.J.	WJLK	1310		Bethlehem, Pa.	WGPA	1000	
Alexandria, Minn.	KXRA	1490	A	Asheboro, N.C.	WGWR	1260		Big Lake, Tex.	WBZ	1330	
Alexandria, Va.	WPIK	780	M	Asheville, N.C.	WLOS	1380	N-M-A	Big Rapids, Mich.	KBLT	1290	
Algonia, Iowa	KLGA	1600			WSKY	1230		Big Sprg., Tex.	KBST	1490	A
Aliga, Tex.	KOPY	1070			WWNC	570	C		KHEM	1270	
Allagash, Mich.	WOWE	1580		Ashland, Ky.	WCMI	1340	C		KBYG	1400	M
Allentown, Pa.	WHOL	1600		Ashland, Ohio	WTCR	1420		Big Stone Gap, Va.	WLSD	1220	
	WABE	790		Ashland, Oreg.	WNCO	1340	M	Bijou, Calif.	KOWL	1490	
	WKAP	1320		Ashland, Wis.	WATW	1400		Bloxix, Miss.	WLOX	1490	M
	WSAN	1470	C	Ashtabula, Ohio	WICA	970			WTVI	570	
Alliance, Nebr.	KCOV	1400		Astoria, Oreg.	KAST	1370	M	Billings, Mont.	KBM1	1240	M
Alliance, Ohio	WFAH	1310			KVAS	1230			KGHL	790	N
Alma, Ga.	WCOS	1400		Atchison, Kans.	KARE	1470			KOOK	970	C
Alma, Mich.	WFYC	1280		Athens, Ala.	WJNW	730			KOYN	910	
Alpena Township, Mich.	WVLF	1450		Athens, Ga.	WDOL	1340			KURL	730	
	WATZ	1450			WFRG	960		Binghamton, N.Y.	WJNR	680	N
Alpine, Tex.	KVLF	1240	M	Athens, Ohio	WATH	970			WJLS	560	C
Alton, Ill.	WOKZ	1570			WOUB	1340			WBNF	1400	
Altona, Man.	CFAM	1290		Athens, Tenn.	WLAR	1450	M	Birmingham, Ala.	WAPI	1070	N
Altosna, Pa.	WFBG	1340	N	Athens, Tex.	KBUD	1410			WBRC	960	C
	WVTA	1240	A	Atlanta, Ga.	WWSL	1390	C		WCRT	1260	A
	WVAM	1430	C		WAKE	1340			WEZB	1260	M
Alturas, Calif.	KCNO	570			WAOK	1380			WENN	1320	M
Altus, Okla.	KWRH	1450			WERD	860			WATV	900	
Alva, Okla.	KALV	1430			WGKA	1600			WSGN	610	
Amarillo, Tex.	KBUY	1010	M		WGST	920	A		WYDE	850	
	KFDA	1440	A		WJNR	730			WVOK	690	
	KGNC	710	N		WOKI	990		Bisbee, Ariz.	KSUN	1230	A
	KIXZ	940	C		WSD	750	N	Bishop, Calif.	KIBS	1230	A
	KRAY	1360			WYZE	1480	M	Bishopville, S.C.	WAGS	380	
				Atlanta, Tex.	KALT	900		Bismarek, N.Dak.	KFR	550	N
				Atlantic, Iowa	KJAN	1220			KOD	1370	
				Atlantic Beach, Fla.	WKTX	1600		Bismarek-Mandan, N.Dak.	KROM	1250	
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Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.
Black River Falls, Wis.	WWIS 1260	Butler, Pa.	WBUT 1050	Chatham, Ont.	CFKO 630	Colonial Heights, Va.	WPVA 1290
Blackfoot, Idaho	KBLL 690	Butte, Mont.	WBSE 680	Chattanooga, Tenn.	WOGA 1450 M	Colorado City, Tex.	KVPM 1320
Blackstone, Va.	WKLV 1440		KBOW 1490 C		WAPQ 1150 A	Colo. Sprgs., Colo.	KRDO 1240
Blackwell, Okla.	KLTR 1580		KOPR 550 M		WDEF 1370 N		KPIK 1580
Blakely, Ga.	WBBK 1260	Cabano, Que.	CJAF 1340		WDOO 1310 C		KVCR 1500 C
Blaine River, Ont.	WZBO 740	Cadillac, Mich.	WNEL 1550 M		WNOQ 1240		KSSS 1400
Bloomington, Ill.	WBBC 1230	Caguas, P.R.	WNL 1550	Cheboygan, Mich.	WCBY 1240		KYSN 1460 M
Bloomington, Ind.	WTTS 1370 A		WDL 1450	Cheektowaga, N.Y.	WNIA 1230	Columbia, Ky.	WAIN 1270
Bloomsburg, Pa.	WCNR 930		WVJP 1110	Chelalis, Wash.	KITI 1420	Columbia, Miss.	WCJU 1450 M
	WHLM 550	Cairo, Ga.	WGRA 790	Chelan, Wash.	KOZI 1220	Columbia, Mo.	KFBU 1400 A
Bluefield, W.Va.	WHIS 1440 N	Cairo, Ill.	WKRO 1490	Cheraw, S.C.	WCRE 1420		KBIA 1580
	WKQY 1240 M	Calais, Maine	WDOY 1230 N	Cherokee, Iowa	KCHE 1440	Columbia, Pa.	WCQY 1580
Blythe, Calif.	KYBY 1450	Caldwell, Idaho	KCID 1490	Chester, Pa.	WVCH 740	Columbia, S.C.	WIS 560 N
Bluytheville, Ark.	KLCN 910	Calera, Ala.	WBV 1370		WGOD 1490		WNOK 1320 C
Boaz, Ala.	WAVC 1300	Calixico, Calif.	KICO 940 A	Chester, S.C.	KFCB 1240 A		WMO 1470
Bogalusa, La.	WIKC 1490 N	Calgary, Alta.	CFAC 960	Cheyenne, Wyo.	KCHY 1590		WMCP 1280
	WBOX 920		CFCN 1060		KVVO 370 M	Columbia, Tenn.	WKRM 1450
Boise, Idaho	KBOI 950 C		KCLX 1140		WAAF 950		WDBK 540 N
	KGEM 1140 M	Calhoun, Ga.	WCGA 900	Chicago, Ill.	WBBT 780 C	Columbus, Ga.	WRBL 1420 C
	KIDP 630 N	Camas, Wash.	KVAN 1490		WCFM 1000		WGBA 1270 M
	KYME 740	Cambridge, Md.	WCBE 1490		WCRW 1240		WCLS 1580
Bonham, Tex.	KFYN 1420	Cambridge, Mass.	WTAO 740 A		WEDC 1240		WOKS 1340
Boone, Iowa	KFGQ 1260	Cambridge, Ohio	WILE 1270		WGES 390	Columbus, Ind.	WCSI 1010
	KWBG 1590	Camden, Ark.	KAMD 910		WGN 720 M	Columbus, Miss.	WVBR 550 M
Boone, N.C.	WATA 1450	Camden, N.J.	WCAM 1810		WIND 1160		WSSS 1400
Boonville, Ind.	WBNI 1540		WKDN 500		WJJD 1260	Columbus, Nebr.	KJSK 900
Boonville, Mo.	KWBR 1370	Camden, S.C.	WACA 1590		WLS 890 A	Columbus, Ohio	WBNS 1460 C
Boonville, Miss.	WBIP 1400	Camden, Tenn.	WCAN 1490		WMAQ 670 N		WCOL 1230 A
Boonville, N.Y.	WBRV 900	Cameron, Tenn.	KMIL 1330		WMBI 1110		WMNI 920
Borger, Tex.	KHUZ 1490 M	Camilla, Ga.	WCLB 1250		WBCB 1240		WOSU 820
	KBBB 1600	Campbell, Ohio	WHOT 1570		WKBK 520 A		WVVO 1580
Bossier City, La.	KBCI 1220	Campbellsville, Ky.	WTCO 1450		WCRW 1240	Colville, Wash.	KCVL 1270
Boston, Mass.	WBOS 1030	Campbellton, N.B.	KCNB 950		WEDC 1240	Commerce, Ga.	WJJC 1270
	WCOP 1150	Camrose, Alta.	CFWC 930		WGES 390	Concord, N.H.	WKXL 1450 C
	WCPI 1090	Canon City, Colo.	KCBY 1490		WGN 720 M	Concord, N.C.	WEGO 1410
	WNAC 680	Canonsburg, Pa.	WCNG 540		WJJD 1260	Concordia, Kans.	KNCK 390
	WEZE 1260 N	Canton, Ga.	WCHK 1290		WMAQ 670 N		KFRM 550 A
	WEEI 950 C	Canton, Ill.	WBYS 1560		WMBI 1110	Conneaut, Ohio	WVVO 1360
	WHDH 850	Canton, Miss.	WDOB 1370		WBCB 1240	Connellsville, Pa.	WCVI 1540
	WMEX 1510	Canton, N.C.	WWIT 970		WCRW 1240	Connersville, Ind.	WCNB 1580
	WORL 950 M	Canton, Ohio	WAND 900		WEDC 1240	Conroe, Tex.	KMCO 900
Boulder, Colo.	KBAN 1410		WAND 900		WGES 390	Conway, Ark.	KCON 1230
Bowie, Tex.	KBAN 1410		WAND 900		WGES 390	Conway, N.H.	WBNO 1580
Bowling Green, Ky.	WKCT 930 A	Cape Girardeau, Mo.	KFVS 960		WJJD 1260	Conway, S.C.	WALA 1330 M
	WBGJ 1410		KGMO 1220		WLS 890 A	Coolidge, Ariz.	CKCY 1150 C
	WLBJ 1410 M		WCIL 1020		WMAQ 670 N	Coos Bay, Ore.	KOOS 1230
Bowl, Green, Ohio	WHRW 730	Carbondale, Ill.	WCIL 1020		WMAQ 670 N		KYNG 1420
Bozeman, Mont.	KXXL 1450 N	Carbondale, Pa.	WCIL 1020		WMAQ 670 N	Copper Hill, Tenn.	WLSB 1400
	KXXL 1450 N	Caribou, Maine	WFST 600		WMAQ 670 N	Couville, Ore.	KWRO 1450
Bradbury Hgts., Md.	WPLO 580	Carlsbad, N.Mex.	KVBE 1240		WMAQ 670 N	Corral Gables, Fla.	WVCG 1900
Bradbrook, Pa.	WLOG 1550		KVBE 1240		WMAQ 670 N	Corbin, Ky.	KCBK 1240 C
Bradenton, Fla.	WTRL 1490		KVBE 1240		WMAQ 670 N	Cordele, Ga.	WMJM 580 M
	WBRD 1420		KVBE 1240		WMAQ 670 N	Cordova, Alaska	KLAM 1450
Bradford, Pa.	WESB 1490 M		KVBE 1240		WMAQ 670 N	Corinth, Miss.	WCMA 1230
Brady, Tex.	KNEL 1490		KVBE 1240		WMAQ 670 N		WCCR 1380
Brainerd, Minn.	KLIZ 1380		KVBE 1240		WMAQ 670 N	Cornelia, Ga.	WCNN 1450
Brampton, Ont.	CHLD 1490		KVBE 1240		WMAQ 670 N	Corner Brook, Nfld.	CBY 790
Brandon, Man.	CKX 1150		KVBE 1240		WMAQ 670 N	Corning, Ark.	WCBA 1350
Branson, Mo.	KBBM 1220		KVBE 1240		WMAQ 670 N	Corning, N.Y.	WCLI 1450 A
Brattleboro, Vt.	WTSB 1450		KVBE 1240		WMAQ 670 N		CJSS 1220
Brawley, Calif.	KROP 1300 A		KVBE 1240		WMAQ 670 N		CFML 1110
Brazil, Ind.	WITE 1380		KVBE 1240		WMAQ 670 N		KBCU 3870
Brookbridge, Minn.	KBMW 1450		KVBE 1240		WMAQ 670 N		KCTA 1030 M
Brookbridge, Tex.	WCCC 1440		KVBE 1240		WMAQ 670 N		KCGT 1150
Bremen, Ga.	WBCC 1440		KVBE 1240		WMAQ 670 N		KEYS 1440
Bremerton, Wash.	KBRD 1490		KVBE 1240		WMAQ 670 N		KRY 1360 N
Brenham, Tex.	KBHI 1280		KVBE 1240		WMAQ 670 N		KXN 1230 A-C
Brevard, N.C.	WPNF 1240 M-N		KVBE 1240		WMAQ 670 N		KUNO 1400
Brewton, Ala.	WBJ 1240 M		KVBE 1240		WMAQ 670 N		KWTR 1370
Bridgeport, Conn.	WICC 600 M		KVBE 1240		WMAQ 670 N		KATN 1340
	WICB 1470		KVBE 1240		WMAQ 670 N		KCF 740 C
Bridgeton, N.J.	WSNJ 1240		KVBE 1240		WMAQ 670 N		KWRT 920
Bridgewater, N.S.	CKBW 1000		KVBE 1240		WMAQ 670 N		KOAC 550
Brigham City, Utah	KBHU 800		KVBE 1240		WMAQ 670 N		KFLY 1240
Brighton, Colo.	KBRN 800		KVBE 1240		WMAQ 670 N		KLOO 1340
Brinkley, Ark.	KBRI 1570		KVBE 1240		WMAQ 670 N		WTNS 1560
Bristol, Conn.	WBIS 1440		KVBE 1240		WMAQ 670 N		
Bristol, Tenn.	WBY 1490		KVBE 1240		WMAQ 670 N		
Bristol, Va.	WCYB 690 A		KVBE 1240		WMAQ 670 N		
	WFHG 980 M		KVBE 1240		WMAQ 670 N		
Brookton, Mass.	WBET 1460		KVBE 1240		WMAQ 670 N		
Brookville, Ont.	CFJR 1450		KVBE 1240		WMAQ 670 N		
Broken Bow, Nebr.	KCNI 1280		KVBE 1240		WMAQ 670 N		
Brookfield, Mo.	KGHM 1470		KVBE 1240		WMAQ 670 N		
Brookhaven, Miss.	WJMB 1340 M		KVBE 1240		WMAQ 670 N		
	WJMB 1340 M		KVBE 1240		WMAQ 670 N		
Brookings, Ore.	KURY 910		KVBE 1240		WMAQ 670 N		
Brookings, S.Dak.	KBRK 1430		KVBE 1240		WMAQ 670 N		
Brookline, Mass.	WBOS 1600		KVBE 1240		WMAQ 670 N		
Brooklyn, N.Y.	WPOW 1330		KVBE 1240		WMAQ 670 N		
Brooksville, Fla.	WWJB 1450		KVBE 1240		WMAQ 670 N		
Brownfield, Tex.	KBY 1300		KVBE 1240		WMAQ 670 N		
Brownsville, Tex.	KBOR 1600		KVBE 1240		WMAQ 670 N		
Brownwood, Tex.	KBWD 1380 M		KVBE 1240		WMAQ 670 N		
	KBAN 1240		KVBE 1240		WMAQ 670 N		
Brunswick, Ga.	WGIG 1440 A		KVBE 1240		WMAQ 670 N		
	WMOG 1490		KVBE 1240		WMAQ 670 N		
Brunswick, Maine	WCME 900		KVBE 1240		WMAQ 670 N		
Bryan, Tex.	KORA 1240 M		KVBE 1240		WMAQ 670 N		
	WTAW 1150		KVBE 1240		WMAQ 670 N		
Buffalo, N.Y.	WBEN 930 C		KVBE 1240		WMAQ 670 N		
	WBNY 1400		KVBE 1240		WMAQ 670 N		
	WEBR 970 M		KVBE 1240		WMAQ 670 N		
	WGR 550		KVBE 1240		WMAQ 670 N		
	WWSB 1520 N		KVBE 1240		WMAQ 670 N		
	WWOL 1120 A		KVBE 1240		WMAQ 670 N		
Buffalo, Wyo.	KBS 1450		KVBE 1240		WMAQ 670 N		
Buford, Ga.	WDM 1460		KVBE 1240		WMAQ 670 N		
Burbank, Calif.	KBLA 1490		KVBE 1240		WMAQ 670 N		
Burley, Idaho	KBAR 1230 A-M		KVBE 1240		WMAQ 670 N		
Burlington, Iowa	KBUR 1490 A		KVBE 1240		WMAQ 670 N		
Burlington, N.C.	WBBB 920 M		KVBE 1240		WMAQ 670 N		
	WBAG 1150		KVBE 1240		WMAQ 670 N		
	WCA 630		KVBE 1240		WMAQ 670 N		
Burlington, Vt.	WDOT 1400		KVBE 1240		WMAQ 670 N		
	WJOY 1230 A		KVBE 1240		WMAQ 670 N		
Burns, Ore.	KRNS 1230		KVBE 1240		WMAQ 670 N		
Butler, Ala.	WPRN 1220		KVBE 1240		WMAQ 670 N		

Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.
Cypress Gardens, Ky.	Fla.WGTO 540	Dover, N.H.	WTSN 1270 W	Escanaba, Mich.	WDDB 680 M	Ft. Scott, Idaho	KMDO 1600
Cynthiana, Ky.	WCYN 400	Dover, Ohio	WJER 1450	Ft. Smith, Ark.	WLST 600 A	KFPW 1230 C	
Dade City, Fla.	WDGF 1350	Doylston, Tenn.	WBUX 1570	Escondido, Calif.	KOWN 1450	KFSA 950 A	
Dalhousie, Tex.	KXIT 1410	Drumheller, Alta.	CJDU 910	Esterville, Iowa	KLIL 1340	KTGS 1410 M	
Dallas, Oreg.	KDAB 1350	Drummondville, Que.		Etowah, Tenn.	WOPH 1270	KWHN 1320	
Dallas, Tex.	KRLD 1080 C	Dublin, Ga.	CHRD 1340	Eufaula, Ala.	WULF 1240 M	Ft. Stockton, Tex.	KWOP 1360
	KIXL 1040		WLMT 1330	Eugene, Oreg.	KORE 1450 A	Ft. Valley, Ga.	WFPM 1150
	KSKY 660		WLXI 1230		KASH 1600 A	Ft. Walton Beach, Fla.	
	KLIF 1190	Du Bois, Pa.	WCED 1420 C		KERG 1280 C		WFBS 950
	WFAA 570 A	Dubuque, Iowa	KDTH 1370 A		KUGN 590 N		WFTW 1260
	WFAA 320 N		WDBQ 1490 M	Eunice, La.	KEUN 1490 M	Ft. Wayne, Ind.	WGL 1250 A
	KBOB 1480	Duluth, Minn.	KDAB 610	Eureka, Calif.	KDNR 790 C		WOWO 1190
The Dalles, Oreg.	WRR 1310 M		WREB 560		KIEM 1480 M		WANE 1450 C
	KACI 1300		WREX 1080		WLCO 1240		WKIG 1380 N
	KODL 1440	Dumas, Tex.	KDDO 800	Eustis, Fla.	WEAW 1330	Ft. William, Ont.	CKPR 580
Dalton, Ga.	WBLJ 1230 M	Duncan, Okla.	KHRD 1350 M	Evanson, Ill.	WVNP 1590		CJLX 800
	WRCD 1430	Dundalk, Md.	WAYE 860		KLUK 1240	Ft. Worth, Tex.	KJIM 870
Danbury, Conn.	WLAD 800	Dundee, N.Y.	WBBB 1360	Evanston, Wyo.	WFL 1270 C		KCUA 1540
Danville, Ill.	WLA 1490	Dunkirk, N.Y.	WDGE 1410	Evansville, Ind.	WGBF 1280 N		KFJZ 1270
	WITY 980	Dunn, N.C.	WCKB 780		WKY 820		KNOK 970 A
Danville, Ky.	WHR 1230 M	Du Quoin, Ill.	WDQN 1580		WJPS 1330 A		WBAP 570 A
Danville, Va.	WBTM 1330 A	Durango, Colo.	KIUP 930	Eveleth, Minn.	WEVE 1340 M		WKOL 1360
	WDTI 970		KDGO 1240	Everett, Wash.	KRKO 1380	Fosteria, Ohio	WFOB 1430
	WDVA 1250 M		KFSO 750		KXTJ 1230	Fountain Inn, S.C.	WFIS 1600
Darlington, S.C.	WILA 1580	Durant, Okla.	WSNC 620 C	Evergreen, Ala.	WBLO 1470	Frankingham, Mass.	WKOX 1190
Dauphin, Man.	WCAR 1050	Durham, N.C.	WSNC 1410	Fairbanks, Alaska		Frankfort, Ind.	WILO 1570
Davenport, Iowa	WOC 1420 N		WSSB 1490		KFAR 660 A-M-N	Frankfort, Ky.	WFKY 990 M
	KWNT 1580		WTIK 1310 A	Fairfax, Va.	KFRB 900 C-A	Franklin, Ky.	WFRK 1300
	KSTT 1170 M	Dyersburg, Tenn.	WDSG 1450	Fairfield, Ill.	WEEL 1310	Franklin, N.C.	WFSC 1050
Dawson, Ga.	WDWD 990		WTRO 1330	Fairfield, Iowa	WFIW 1390	Franklin, Pa.	WFRS 500
Dawson, Yukon T.	CFYT 1230	Eagle Pass, Tex.	KEPS 1370	Fairfield, Iowa	KMCD 1570	Franklin, Tenn.	WAGG 950
Dawson Creek, B.C.	CJBC 1350	Easley, S.C.	WELP 1360	Fairmont, Minn.	WSMN 1370 M	Franklin, Va.	WYSR 1250
Dayton, Ohio	WJUN 1230 C	E. Grand Forks, Minn.	KRAD 1590	Fairmont, W.Va.	WMMO 920 C	Frederick, Md.	WFMD 930 C
	WING 1410		KERC 1590		WTCS 1490 A	Frederick, Okla.	KTAT 1570
	WONE 980	Eastland, Tex.	KERC 1590	Fajardo, P.R.	WMDD 1490	Fredericksburg, Tex.	
	WAVI 1210	E. Lansing, Mich.	WKAR 870	Fallurrias, Tex.	KPSO 1250	Fredericksburg, Va.	KNAF 910 M
Dayton, Tenn.	WDNT 1280	E. Liverpool, Ohio	WOHI 1490 A	Fallon, Nev.	KULV 1250	Fredericton, N.B.	CFNB 550
Daytona Beach, Fla.	WDND 1150 M-A	East Longmeadow, Mass.	WTYM 1600	Fall River, Mass.	WLE 1480 A	Frederonia, N.Y.	WBUS 1570
	WDMF 1450		WTJN 1290		WLE 1480 A	Freeport, Ill.	WFLR 1570
	WMRP 1480	E. Point, Ga.	WTJN 1290	Falls Church, Va.	WFAX 1220	Freeport, N.Y.	WGBB 1240
Deadwood, S.Dak.	KDSJ 980	E. St. Louis, Ill.	WEEX 1230	Falls City, Nebr.	KTNC 1230	Freeport, Tex.	KBRZ 1460
Dearborn, Mich.	WKMH 1310	Easton, Pa.	WEST 1400 N	Fargo, N.Dak.	WDAY 970 N	Fremont, Mich.	WFOJ 1490
Decatur, Ala.	WHOS 800		WHTG 1400		KFNW 900	Fremont, Nebr.	KHUS 1340
	WAJF 1490	Eatonston, N.J.	WEAQ 790 N		KXGO 790 A	Fremont, Ohio	WFRQ 900
Decatur, Ga.	WNLS 1400 M	Eau Claire, Wis.	WBIZ 1440 M	Fairbault, Minn.	KDHL 920	Fresno, Calif.	KARM 1430 A
Decatur, Ill.	WCHN 1010		WECF 1050	Fairfax, Me.	KREI 1380		KBFJ 900
	WDZ 1050	Eau Gallie, Fla.	WMES 1320	Farmington, Me.	KREI 1380		KEAP 980
Decorah, Iowa	WSOY 1340 C	Edenton, N.C.	WCDJ 1260	Farmington, N.M.	KWYK 950		KFRE 940 C
	KDEC 1240	Edinburg, Tex.	KURV 710		KZUM 1280		KMAK 1600
	KWLC 1240	Edmonds, Wash.	KGDN 630		WBLT 1050		KMTJ 1340
Defiance, Ohio	WONW 1280	Edmonton, Alta.	CBX 1010	Farmville, N.C.	WBTL 1050		KMJ 580 N
De Funiak Springs, Fla.	WDSP 1280		CBXA 740	Farmville, Va.	WBTC 1250	Front Royal, Va.	KYNO 1450 M
	WZEP 1460		CFRN 1250	Farmville, Va.	WFLR 1470	Frostburg, Md.	WFRB 740
De Kalb, Ill.	WLBB 1360		CHFA 680	Fayette, Ala.	WWWF 990	Fulton, Ky.	WFUL 1270
De Land, Fla.	WBBS 1490		CJCA 930	Fayetteville, Ark.	KHOG 1450	Fulton, Mo.	KFAL 900
	WOOO 1310		CKUA 580		KFAY 1250 M	Fulton, N.Y.	WOSC 1300
Delano, Calif.	KCHJ 1010	Edmundston, N.C.	CJEM 570	Fayetteville, N.C.	WFAI 1230 C	Fuquay Sprgs., N.C.	
Delray, Bch., Fla.	WDBF 1420	Effingham, Ill.	WCRA 1090		WFNC 1390 M		WFVG 1460
Del Rio, Tex.	KDLK 1230	Elba, Ala.	WELB 1350		WFLB 1490 A	Gadsden, Ala.	WGAD 1350 A
Delta, Colo.	KOTA 1400	Elberton, Ga.	WESG 1400		WIDU 1600		WETO 930 M
Deming, N.Mex.	KOTS 1230	El Cajon, Calif.	KDEO 910 A	Fayetteville, Tenn.	WEKR 1240 M	Gaffney, S.C.	WFGN 1570
Demopolis, Ala.	KWAL 1400 M	El Campo, Tex.	KULP 1390	Fergus Falls, Minn.	KOTE 1250 M	Gainesville, Fla.	WVFN 1280
Denham Sprgs., La.	WLBH 1220	El Centro, Calif.	KXO 1230 M				WGGG 1230 A
Denison, Iowa	KDSN 1580		KAMP 1430				WRUF 850 M
Denison, Tex.	KDSX 950	El Dorado, Ark.	KDMS 1290				WVFN 1280
Denton, Tex.	KDNT 1440		KELD 1400 A				WVFN 1280
Denver, Colo.	KDNT 1340	Eldorado, Kans.	KDMS 1290				WVFN 1280
	KFML 1360	Elgin, Ill.	WRMN 1410				WVFN 1280
	KHGW 630 A	Elizabeth City, N.C.	WCNC 1240				WVFN 1280
	KIMN 950 M		WGAJ 560				WVFN 1280
	KLIR 990		WBEJ 1240				WVFN 1280
	KLZ 560		WIEL 1400				WVFN 1280
	KION 710						WVFN 1280
	KKO 850						WVFN 1280
	KPOT 910						WVFN 1280
	KFSC 1220						WVFN 1280
	KTLN 1280						WVFN 1280
De Queen, Ark.	KDQN 1390						WVFN 1280
Des Moines, Ia.	KOLA 1010						WVFN 1280
Des Moines, Iowa	KQBC 1390 A						WVFN 1280
	KIOA 1040						WVFN 1280
	KRNT 1350						WVFN 1280
	KSO 1460						WVFN 1280
	KWKY 1150 M						WVFN 1280
	WHO 1040						WVFN 1280
Detroit, Mich.	WCAR 1130						WVFN 1280
	WJBK 1500						WVFN 1280
	WJLB 1400						WVFN 1280
	WJR 760						WVFN 1280
	WWJ 950						WVFN 1280
	WXYZ 1270 A						WVFN 1280
Detroit Lakes, Minn.	KDLM 1340						WVFN 1280
Devils Lake, N.Dak.	KDLR 1240 M						WVFN 1280
Dexter, Mo.	KDEX 1590						WVFN 1280
Diboll, Tex.	KSPX 1260						WVFN 1280
Dickinson, N.Dak.	KDIX 1230						WVFN 1280
Dickson, Tenn.	WDKN 1260						WVFN 1280
Dillon, Mont.	KDMM 800						WVFN 1280
Dillon, S.C.	WDSC 800 A						WVFN 1280
Dinuba, Calif.	KRDB 1240						WVFN 1280
Dodge City, Kans.	KGNO 1370 M						WVFN 1280
Dothan, Ala.	WAGF 1320						WVFN 1280
	WDIG 1450						WVFN 1280
	WOOF 560						WVFN 1280
Douglas, Ariz.	KAWT 1450 M						WVFN 1280
	KAPR 930						WVFN 1280
Douglas, Ga.	WDMG 860						WVFN 1280
Douglas, Wyo.	KWYK 1050						WVFN 1280
Dover, Del.	WDOW 1410						WVFN 1280
	WKEN 1600						WVFN 1280
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Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.
Gonzales, Tex.	WGBR 1150 A	Harlan, Ky.	WHLN 1410	Howell, Mich.	KYOK 1590	Kailua, Hawaii	KANI 1240
Goodland, Kans.	WGOL 1300	Harlingen, Tex.	KGST 1530	Hudson, N.Y.	WHMI 1350	Kaimuki, Hawaii	KAIM 870
Goshen, Pa. Nfld.	KBRL 730 M	Harrison, Tenn.	WBRT 1600	Hugo, Okla.	WHUC 1230	Kalamazoo, Mich.	WKZO 590 C
Goshen, Ind.	CFGB 1340	Harrisburg, Ill.	WBRT 1600	Hull, Que.	CKCH 970		WKLT 1470 M
Grafton, N.D.	WKAM 1460	Harrisburg, Pa.	WHBG 1400 A	Humacao, P.R.	WALO 1240	Kalispell, Mont.	KGFI 800 M
Grafton, W.Va.	KGPC 1340		WCMB 1460 A	Humboldt, Tenn.	WIRJ 740		KOFI 930
Graham, Tex.	WVVW 1260	Harrison, Ark.	WHP 580 C	Huntingdon, Pa.	WHUN 1150	Kamloops, B.C.	CFIC 910
Granby, Que.	KSWA 1330	Harrisburg, Va.	KHOZ 900	Huntingdon, Ind.	WHLT 1300	Kane, Pa.	WADP 960
Grand Falls, Nfld.	CHFE 1450		WHBG 1300	Huntington, N.Y.	WGSW 740	Kankakee, Ill.	WKAN 1320
Grand Forks, N.Dak.	CBT 970		WHBN 1420	Huntington, W.Va.		Kannapolis, N.C.	WBTL 870
	KFMJ 1390	Harrodsburg, Ky.	WDRG 1360 C		WPLH 1470 M	Kansas City, Kans.	KCKN 1360
Grand Coulee, Wash.	KFDR 1360	Hartford, Conn.	WCCC 1290		WKEE 800 M-A	Kansas City, Mo.	KCMO 810 C
	KILO 1440 C		WPOP 1410 M-A	Huntsville, Ala.	WSAZ 930 N		KMBC 980 A
	KNOX 1310 M		WTIC 1080 N		WBHP 1230 M		KPRS 1590
Grand Haven, Mich.	WGHN 1370	Hartford, Wis.	WTKM 1490		WEUP 1600		KUDL 1380
		Hartsville, Ala.	WHBT 860		WFUN 1450		WDAF 610 N
Grand Island, Nebr.	KMMJ 750 A	Hartsville, S.C.	WHSC 1450 M		WYAY 1550 A		WHB 710
	KRGI 1430	Hartwell, Ga.	WKLY 980	Huntsville, Ont.	CKAR 1490		KGFW 1340 M
		Harvard, Ill.	WMCW 1600	Huron, S.Dak.	KIJV 1340	Keene, N.H.	WKNE 1220 N
Grand Junction, Colo.	KREX 920 M	Harvey, Ill.	WBEE 1570	Hutchinson, Kans.	KWBW 1450 N		WKBK 1290
	KEXO 1230	Hastings, Mich.	WBCH 1220		KVWH 1260	Kelowna, B.C.	CKOV 630
	KSTN 620	Hastings, Nebr.	KHAS 1280	Hutchinson, Minn.	KDUZ 1260	Kelso, Wash.	KLOG 1490
Grande Prairie, Alta.	KKSN 730	Hattiesburg, Miss.	WHBS 950	Idabel, Okla.	KBEL 1240	Kendallville, Ind.	WAWK 1570
Grand Prairie, Tex.	KKSN 730		WHBY 1430 A	Idaho Falls, Idaho	KID 590 C	Kendy, Tex.	KANL 1800
Grand Rapids, Mich.			WHXX 1310		KIFI 1260 A-M	Kenmore, N.Y.	KNO 1080
	WJEF 1230 C	Haverhill, Mass.	WHAV 1490	Independence, Kans.	KUPI 980	Kennerly, Mo.	KBOA 830
	WFUR 1570	Havre, Mont.	KOJM 610 M		KIND 1010 M	Kennewick-Pasco-Richland, Wash.	KEPR 610 C
	WGRD 1410	Havre de Grace, Md.	WASA 1330	Independence, Mo.	KANS 1510	Kenora, Ont.	CJRL 1220
	WLAF 1340		WCEH 610	Indiana, Pa.	WDAD 1450 C	Kenosha, Wis.	WLIP 1050
	WMAX 1480 M	Hawkinsville, Ga.	KLUV 1580	Indianapolis, Ind.		Kentville, N.S.	CKEN 3550
	WOOD 1300 N	Hays, Kans.	KAYS 1400		WFBM 1260 A-M	Keokuk, Iowa	KOKX 1310
Grand Rapids, Minn.	KOZY 1490 M	Hayward, Wis.	WHSM 910		WGEE 590	Kermic, Tex.	KERV 800
Grangeville, Idaho	KORT 1230	Hazard, Ky.	WKIC 1390 M		WIBC 1070	Kerrville, Tex.	KERV 1230
Grants, N.Mex.	KMIN 980	Hazlehurst, Miss.	WMDC 1220		WIRE 1430 N	Ketchikan, Alaska	KTKN 930 C-A
Grants Pass, Ore.	KAGI 1340 M	Hazleton, Pa.	WAZL 1490 N-M		WISH 1310 C	Kewanee, Ill.	WKEL 1450
	KAJO 1370	Helena, Ark.	KCAP 1340 M		WXLW 950	Keyser, W.Va.	WKYR 1270
Gravelbourg, Sask.	CFGR 1230	Helena, Mont.	KXLJ 1240 N	Indianola, Miss.	WDLT 1380	Key West, Fla.	WKWF 1600 M
	CFRG 710		KHSH 1320		KRBN 1400 A		WKIZ 1500
Grayson, Ky.	WGOW 1370	Hemet, Calif.	KHSH 1320	Inglewood, Calif.	KTYM 1460	Kilgore, Tex.	WKIL 1500
Gt. Barrington, Mass.		Hempstead, N.Y.	WHLI 1100	Inkster, Mich.	WCHB 1440	Killeen, Tex.	KLEN 1050 M
	WSBS 860	Henderson, Ky.	WSON 860	International Falls, Minn.	KGHS 1230	Kimball, Nebr.	KIMB 1620
Gt. Bend, Kans.	KVGB 1590 N	Henderson, Nev.	KBMI 1400	Ionia, Mich.	WION 1430	King City, Calif.	KRIC 1570
Gt. Falls, Mont.	KUDL 1450 C	Henderson, N.C.	KTOD 1280	Iowa City, Iowa	KXIC 800	Kingman, Ariz.	KAAA 1230 A
	KMN 560 M	Henderson, Tex.	WHVH 1450		WSUI 910	Kings Mountain, N.C.	WKMT 1220
	KARR 1400 N		KJAT 1000	Iron Mtn., Mich.	WMI 1430 A	Kingsport, Tenn.	WKPT 1420
Greeley, Colo.	KFKA 1410	Hendersonville, N.C.	KWRD 1470	Iron River, Mich.	KWBK 230 M	Kingston, N.Y.	WKNY 1490 M
	KYOU 1350		WHKP 1450 A	Irontron, Ohio	WIRO 230 M	Kingston, Ont.	CFRC 1490
Green Bay, Wis.	WBAY 1360 C	Henryetta, Okla.	KHEN 1590	Ironwood, Mich.	WIMS 630 M		CKLC 1380
	WDUZ 1400 A	Hersford, Tex.	KWAL 1420	Ishpeming, Mich.	WJPD 1240		CKWS 960
Green Cove Springs, Fla.	WGRC 1580	Herkimer, N.Y.	KOHU 1570		WJAN 970	Kingstree, S.C.	WDKD 1310
Greenville, Tenn.	WGRV 1340	Herrin, Ill.	WJPF 1340 M	Islip, N.Y.	WBIC 540	Kingsville, Tex.	KINE 1330
Greensboro, N.C.	WBIG 1470 C	Hettinger, N.Dak.	KNDP 1490	Ithaca, N.Y.	WELC 1470 A	Kinston, N.C.	WELC 1010
	WCOG 1320	Hickory, Minn.	WMFG 1420 N	Jackson, Ala.	WTHG 1290 M		WFTC 960 A
	WPEI 950 A	Hickory, N.C.	WHKY 1230 A	Jackson, Mich.	WIBM 1450 A		WISP 1320 M
	WJHB 620	High Point, N.C.	WIRC 1230	Jackson, Miss.	WKHM 970 M	Kirkland, Wash.	KNBX 1050
Greensburg, Pa.	WGYV 1380		WNOS 1590		WJDX 620 N	Kirkland Lake, Ont.	CJKL 560
Greenville, Ala.	WJPR 1330	Hillsboro, Ohio	WSRW 1590		WJGS 1400	Kirkville, Mo.	KIRX 1450 A
Greenville, Miss.	WDDT 900	Hillsboro, Ohio	KUIK 1360		WJMS 1400	Kissimmee, Fla.	WKBX 1450
	WGVV 1260	Hillsboro, Tex.	KHBR 1590		WJOK 1590	Kitchener, Ont.	CKKW 1320
Greenville, N.C.	WGSC 1590 M	Hillsdale, Mich.	WCSS 1340	Jackson, Ohio	WREB 1300 M	Kittanning, Pa.	WACB 1380
Greenville, S.C.	WFBC 1330 N	Hilo, Hawaii	KIPA 1110	Jackson, Tenn.	WLSI 930	Klamath Falls, Ore.	KAGO 1150 M
	WMBR 1490 A-M		KIMO 850 M		WLMI 1280		KFLW 1450 A-C
	WMUU 1260	Hobart, Okla.	KTJS 1420	Jacksonville, Fla.	WJAK 1460		KLAD 960
	WQOK 1440 C	Hobbs, N.Mex.	KWEW 1480 M		WJAS 930	Knoxville, Tenn.	WVW 1230 A
Greenville, Tex.	KGVL 1400		KHOB 1280		WJAX 930		WVTE 860
Greenwood, Miss.	WABG 960 A	Holbrook, Ariz.	KDJI 1270		WJBE 690		WVTE 620 N
	WABG 960 A	Holbrook, Ariz.	KDJI 1270		WJBY 1050		WKGN 1340 M
Greenwood, S.C.	WCBS 1450 N	Holland, Mich.	WHTE 1450		WJBY 1050		WKXV 930 M
	WGSW 1350		WJBL 1260		WJBY 1050		WNXX 990 C
Greer, S.C.	WEAB 830	Hollywood, Fla.	WGMA 1320		WJBY 1050		WVTE 620 N
	WCKI 1300 A	Holyoke, Mass.	WREB 930		WJBY 1050		WVTE 620 N
Grenada, Miss.	WNAG 1400 M	Homer, La.	KVHL 1320		WJBY 1050		WVTE 620 N
Gresham, Ore.	KGRO 1230	Homestead, Fla.	WDSB 1480		WJBY 1050		WVTE 620 N
Gretna, Va.	WNA 720	Homestead, Pa.	WAMO 860		WJBY 1050		WVTE 620 N
Griffin, Ga.	WKEU 1450 M	Homewood, Ala.	WJLD 1400		WJBY 1050		WVTE 620 N
	WHIE 1320	Honolulu, Hawaii	KGMB 590 C		WJBY 1050		WVTE 620 N
Grinnell, Iowa	KGRN 1410		KPOI 1380		WJBY 1050		WVTE 620 N
Groton, Conn.	WSUB 980		KIKI 830		WJBY 1050		WVTE 620 N
Grove City, Pa.	WSAJ 1340		KGU 760 N		WJBY 1050		WVTE 620 N
Grundy, Va.	WNRG 1250		KHVV 1040		WJBY 1050		WVTE 620 N
Guayama, P.R.	WXPR 1590		KOD 990		WJBY 1050		WVTE 620 N
Guilford, Ont.	CJOY 1450		KOD 990		WJBY 1050		WVTE 620 N
Gulfport, Miss.	WROA 1390		KPOA 630 M		WJBY 1050		WVTE 620 N
	WGCN 1240 A		KULA 690 A		WJBY 1050		WVTE 620 N
Guntersville, Ala.	WGSV 1270		KIHR 1340		WJBY 1050		WVTE 620 N
Guthrie, Okla.	KWRV 1490		KXAR 1490		WJBY 1050		WVTE 620 N
Guyon, Okla.	KGYN 1220		WHAP 1340		WJBY 1050		WVTE 620 N
Hagerstown, Md.	WARK 1490 C		WHOP 1280		WJBY 1050		WVTE 620 N
	WJ 1240 A-M		WHOP 1280		WJBY 1050		WVTE 620 N
Haleyville, Ala.	WJBB 1230 M		WHOP 1280		WJBY 1050		WVTE 620 N
Halifax, N.S.	CBH 1330		WHOP 1280		WJBY 1050		WVTE 620 N
	CHNS 960		WHOP 1280		WJBY 1050		WVTE 620 N
	CJCH 920		WHOP 1280		WJBY 1050		WVTE 620 N
Hamilton, Ala.	WERH 970		WHOP 1280		WJBY 1050		WVTE 620 N
Hamilton, Ohio	WMOH 1450		WHOP 1280		WJBY 1050		WVTE 620 N
Hamilton, Ont.	CHMO 900		WHOP 1280		WJBY 1050		WVTE 620 N
	CKLW 900		WHOP 1280		WJBY 1050		WVTE 620 N
Hamlet, N.C.	WKDX 1400		WHOP 1280		WJBY 1050		WVTE 620 N
Hammond, Ind.	WDJO 1230		WHOP 1280		WJBY 1050		WVTE 620 N
Hammond, La.	WFRP 1400		WHOP 1280		WJBY 1050		WVTE 620 N
Hampton, S.C.	WBHC 1270		WHOP 1280		WJBY 1050		WVTE 620 N
Hampton, Va.	WVEC 1480		WHOP 1280		WJBY 1050		WVTE 620 N
Hanock, Mich.	WMFC 920		WHOP 1280		WJBY 1050		WVTE 620 N
Hanford, Calif.	KNGS 620		WHOP 1280		WJBY 1050		WVTE 620 N
Hannibal, Mo.	KHMO 1070		WHOP 1280		WJBY 1050		WVTE 620 N
Hanover, N.H.	WTSI 1400		WHOP 1280		WJBY 1050		WVTE 620 N
	WDCR 1340		WHOP 1280		WJBY 1050		WVTE 620 N
Hanover, Pa.	WHVR 1280		WHOP 1280		WJBY 1050		WVTE 620 N

Location	C.L.	Kc.	N.A.	Location	C.L.	Kc.	N.A.	Location	C.L.	Kc.	N.A.	Location	C.L.	Kc.	N.A.
Lancaster, Calif.		KAVL 810		Lock Haven, Pa.		WBPZ 1230	M	Marinette, Wis.		WMAM 570	N	Midland, Tex.		KCRS 550	A
Lancaster, Ohio		KBVM 1380		Lockport, N.Y.		WUSJ 1340		Marion, Ala.		WJAM 1310		KJBI 1350			
Lancaster, Pa.		WHOK 1320		Lodi, Calif.		KCVR 1570		Marion, Ind.		WGGH 1150		KWEL 1600			
Lancaster, S.C.		WGAN 1490	N	Logan, Utah		KVND 610	M	Marion, N.C.		WBAT 1400	A	Milan, Tenn.		WKBJ 1600	
Lander, Wyo.		WLAN 1390	A-M	Logan, W.Va.		KLGN 1390		Marion, Ohio		WMRI 860		Miles City, Mont.		KATL 1340	M
Landett, Ala.		WLCM 1360		Logansport, Ind.		WLOG 1230	M	Marion, S.C.		WBRM 1250		Milford, Del.		WKSB 930	
Lansford, Pa.		WLRL 1490	A	Lompoc, Calif.		WWSW 1290		Marked Tree, Ark.		WMRN 1490	A	Milledgeville, Ga.		WMRC 1490	
Lansing, Mich.		WLSD 1410		London, Ky.		WWSA 1230	M	Marshall, Mo.		WATP 1430	A	Millen, Ga.		WMVG 1450	M
Lapeer, Mich.		WLSL 1320		London, Ont.		WFTG 1400		Marshall, Tex.		KPCA 1580		Millington, Tenn.		WGSR 1570	
LaPorte, Ind.		WJIM 1240	A-N	Long Beach, Calif.		KCPFL 980		Marshalltown, Iowa		KAPB 1370		Millville, N.J.		WMVB 1460	
Laramie, Wyo.		WMPC 1230		Longmont, Colo.		CKSL 1290		Marshalltown, Iowa		WSRO 1070		Milton, Fla.		WBEY 1330	M
Laredo, Tex.		WLOI 1540		Long Prairie, Minn.		KFOX 1280		Marshalltown, Iowa		KMLW 1410		Milwaukee, Wis.		WSRA 1490	
LaSalle, Ill.		KOWB 1340	M	Longview, Tex.		KGER 1390		Marquette, Mich.		WDMJ 1320	M	Minden, La.		WMLP 1250	
LaSalle, N.Mex.		KVOZ 1490	M	Longview, Wash.		KLMO 1050		Marshall, Minn.		KMHJ 1400	A	Mineral Wells, Tex.		WEMP 1570	
Las Cruces, N.Mex.		WLPO 1220		Lorain, Ohio		KEYL 1400		Marshall, Mo.		KMHD 1300		Minneapolis, Minn.		WFOG 860	M
Las Vegas, Nev.		KOBE 1450		Loris, S.C.		KFRD 1370		Marshall, N.C.		KMTT 1450				WISN 1510	A
Latrobe, Pa.		KGRT 570		Los Alamos, N.Mex.		KEDO 1400	A	Marshall, Tex.		KADO 1410				WMIL 1290	
LaTuque, Que.		KENO 1460	A	Los Angeles, Calif.		KBAM 1270		Marshalltown, Iowa		KFJB 1230				WKY 920	N
Laurens, S.C.		KLAS 1230	C			WWJZ 1380		Marshalltown, Iowa		WDLB 1450				WTMJ 620	N
Laurinburg, N.C.		KORR 1340	M			WLSC 1570		Marshalltown, Iowa		WCMT 1410				KASD 1240	
Lawrence, Kans.		KRAM 920				KRSN 1490	A	Marshalltown, Iowa		WSPM 1340				KORO 1140	
Lawrence, Mass.		KRBO 1050				KABC 790	A	Marshalltown, Iowa		WVMA 1450	N			WCCC 830	C
Lawrenceburg, Tenn.		WSHH 1570	M			KFI 640	N	Marshalltown, Iowa		KMYC 1410	M			WLCL 1330	
Lawrenceville, Ga.		WTRA 1480				KFSG 1150	M	Marshalltown, Iowa		KNDY 1570	M			WMIN 1400	
Lawton, Okla.		WAML 1340	N			KFWB 980		Marshalltown, Iowa		KNIM 1580				WDGJ 1130	
		WLAW 1600	A			KGFI 1230		Marshalltown, Iowa		WGAP 1400				WPBY 980	
		WNSL 1260				KFCAC 1330		Marshalltown, Iowa		KGLO 1300	C			WTGN 1280	A
		WLBG 860				KLAC 570		Marshalltown, Iowa		KRIE 1490				WVTV 900	
		WVLO 1080				KMPC 710		Marshalltown, Iowa		KSMN 1010				KUON 970	
		KFKU 1250				KNX 1070	C	Massena, N.Y.		WMSA 1340	A			KLPM 1390	M
		KLWN 1320				KPOP 1020		Massena, N.Y.		WSTS 1050				KQDY 1320	
		WCCM 800	M			KRKD 1150		Massena, N.Y.		WTIG 990				KCJB 910	C
		WDXE 1370				KRWV 1280		Massena, N.Y.		CKBL 1250				KBKC 1480	
		WLAW 1360				KWYN 1470	N	Massena, N.Y.		WHJC 1360				KIRT 1580	
		WAKO 910				WAVE 980	N	Massena, N.Y.		WLEH 1370				KQVO 1260	
		KSWO 1380	A			WAKY 790	M	Massena, N.Y.		WAL 600				KXIL 1450	C
		KOCO 1050				WHAS 840	C	Massena, N.Y.		WKJB 710				KQTE 940	M
		KLVC 1280				WKLO 1080	A	Massena, N.Y.		WORA 1150				KYSS 910	
		WLOE 1490	M			WNN 1240		Massena, N.Y.		WPR 990				KORN 1490	M
		CJSP 710				WCKW 900		Massena, N.Y.		WTL 1300				KURA 1450	
		KCLO 1410				WLOU 1350		Massena, N.Y.		WNGO 1320				KNCM 1230	
		WLBN 1590				WTMT 620		Massena, N.Y.		WMYN 1420				WLIA 1410	N
		KLWT 1230				WLSM 1270		Massena, N.Y.		WFT 730	M			WGOK 900	
		KGAL 920				KLV 1570		Massena, N.Y.		KTMC 1400				WKAB 840	
		WLBK 1270				KLEA 630		Massena, N.Y.		KNED 1150				WKRG 910	
		WCB 900				KCAP 980		Massena, N.Y.		KRIO 910	M			WMOZ 760	
		WLBE 790	M			WLLH 1400		Massena, N.Y.		KCMR 1450				KTRY 1300	
		WBIL 1410				KCD 1590	N	Massena, N.Y.		WHNY 1250	A			KOLB 860	
		WAGE 1290				KDAB 580		Massena, N.Y.		WAF 980				KTB 900	
		KLLA 1570				KDUB 1340		Massena, N.Y.		KBR 1300	M			KFV 1360	A
		WMTL 1580				KFYD 790	C	Massena, N.Y.		WED 810				WQUA 1230	A
		WESY 1580				KLL 1460	M	Massena, N.Y.		WCMK 1360				KVKM 1340	M
		KLEM 1410				KSEL 950	A	Massena, N.Y.		WHD 1440				CBFA 380	
		WLN 1340	M			WCLA 1450	A	Massena, N.Y.		KMAE 1260				CKCW 1220	
		WLIL 730				KRBA 1430	A	Massena, N.Y.		KMCM 1260				KRMO 960	
		WKIK 1370				KTB 1420	M	Massena, N.Y.		WBMC 960				WGL 1330	
		CJOC 1220				WAGR 580		Massena, N.Y.		WBN 730				WMRE 1490	
		CHEC 1090				WTSB 1340	M	Massena, N.Y.		KNE 1540				KMLB 1440	A-N
		KLVT 1230				WLVA 590	A	Massena, N.Y.		WDX 1410				KLIC 1230	M
		WBCE 1490				WWD 1390	M-N	Massena, N.Y.		WDM 1440				KNOE 1390	
		WJMT 1010				WBRG 1050		Massena, N.Y.		WHL 1430				WMIC 560	
		WJIM 1490	M			WLYN 1360		Massena, N.Y.		KMED 1440	N			WNAP 1060	
		KRLC 1350	M			WBST 1340		Massena, N.Y.		KDOV 1300				WMA 1260	
		KOZE 1300				WK 1510		Massena, N.Y.		WAGN 1230				WVFC 1360	
		WCOU 1240	M			WBML 1240		Massena, N.Y.		KYJC 1230	A-C			KIDD 830	
		WLAM 1470	A			WCY 900		Massena, N.Y.		WIGM 1490	M			KMBY 1240	C
		KXLO 1230	M			WIBB 1280		Massena, N.Y.		CHAT 1270				KDMA 1450	A
		WKVA 920				WMAZ 940	C	Massena, N.Y.		WMBB 1240	M			KSLV 1240	
		WMRF 1490	N			WNE 1400	A-M	Massena, N.Y.		WHBQ 560	M			WBAW 740	
		WBLG 300	A			WBMC 1400		Massena, N.Y.		WHER 1430				WAPX 1600	A
		WVTK 590	M			WHOT 1250		Massena, N.Y.		WMC 790	N			WHY 1440	N
		WXTN 1150				WMA 1230		Massena, N.Y.		WDL 1410				WMGY 800	
		KLEX 1570				WYTH 1250		Massena, N.Y.		WMPS 680				WRMA 950	
		KRYN 1010				WORX 1270		Massena, N.Y.		WHHM 1340	A			WMON 1340	M
		WBUY 1440				WHA 970		Massena, N.Y.		WLOK 1480				WFLW 1360	
		WDXL 1500	N			WIBA 1310	N	Massena, N.Y.		WREC 600	C			CKBM 1490	
		WEL 1450				WISM 1480	A-M	Massena, N.Y.		KWAM 990				WSKI 1240	A
		WPTX 920				WKOW 1070	C	Massena, N.Y.		KENA 450				CBF 690	N
		KLGB 1230	M			WENO 1430		Massena, N.Y.		WNE 360				CJAD 800	A
		KSCB 1270				WFTL 1310		Massena, N.Y.		KYOS 1480	M			CKMS 1280	
		WVOS 1240				WFSJ 1280		Massena, N.Y.		KWIP 1580				CKAG 730	C
		KWLD 1050				KVMA 630	M	Massena, N.Y.		WMW 1470				CKGM 980	
		KTOH 1490				KTCB 1470		Massena, N.Y.		WCO 910	C			KUBC 580	
		WIMA 1150	A			KWIC 1490	M	Massena, N.Y.		WDAL 1330				WEL 1250	
		WPRG 1370				KBOK 1310		Massena, N.Y.		WMOX 1240				WVFC 1360	
		KFOR 1240	A			KPRW 1460		Massena, N.Y.		WOKK 1450	A			WVFC 1360	
		KLIN 1400				WLN 1230		Massena, N.Y.		WQIC 1390				WVFC 1360	
		KLMS 1480				WFD 1370		Massena, N.Y.		KBUZ 1310				WVFC 1360	
		WLON 1050				WXL 1450		Massena, N.Y.		WMOK 920				WVFC 1360	
		CKLY 910				WFEA 1370		Massena, N.Y.		KBUS 1590				WVFC 1360	
		WBTO 1600				WGR 610	C	Massena, N.Y.		KXED 1340				WVFC 1360	
		WSMI 1540				WKR 1240		Massena, N.Y.		WU 1220				WVFC 1360	
		KLFD 1410				WMSR 1320		Massena, N.Y.		KIKO 1340				WVFC 1360	
		KLFE 980				KMAN 1350		Massena, N.Y.		WGBS 710	C			WVFC 1360	
		WLH 1230				WMT 1340		Massena, N.Y.		WCKR 910	N			WVFC 1360	
		KZZN 1490				KCMS 1490		Massena, N.Y.		WFFC 1220				WVFC 1360	
		KARK 920	N			WCU 980		Massena, N.Y.		WAME 1260				WVFC 1360	
		KAJI 1250	M			WOMT 1240	M	Massena, N.Y.		WIE 1140				WVFC 1360	
		KLRA 1010	A			WQST 1240		Massena, N.Y.		WDM 560				WVFC 1360	
		KOKY 1440				WQSP 1450		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KTIS 1090	C			WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KVTE 1050				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KMOR 1510				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		WNER 1520				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KPRK 1340	M			WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		WLIV 920				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KETX 1440				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		KLBS 1220				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
		CKSA 1150				WVFC 1360		Massena, N.Y.		WVFC 1360				WVFC 1360	
						WVFC 1360		Massena, N.Y.		WVFC					

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Location	C.L. Ke. N.A.	Location	C.L. Ke. N.A.	Location	C.L. Ke. N.A.	Location	C.L. Ke. N.A.
Port Neches, Tex.	KPDQ 800	Reno, Nev.	KOH 630 N	St. Augustine, Fla.	WFOY 1240 C	San Jose, Calif.	KYA 1260
Portsmouth, N.H.	KPOJ 1030 M		KBET 1340 M	St. Boniface, Man.	WSTN 1420		KLOK 1170
Portsmouth, Ohio	KKL 750		KOB 920 C	St. Catherine's, Ont.	KCSB 1050		KLIV 1590
	KPNQ 1150	Renton, Wash.	KONE 1450	St. Charles, Mo.	KCTB 610		KEEN 1870
	WHBE 750	Rexburg, Idaho	KDOT 1230	St. Cloud, Minn.	KADY 1450	San Juan, P.R.	KXRX 1460
	WNXT 1260 A	Rhineland, Wis.	KUDY 910		KFM 1450 N		WHOA 1400
Portland, Va.	WLOW 1400 A	Rice Lake, Wis.	KRWK 1230	St. George, Utah	WJON 1450		WIPR 940
	WAVY 1350 N	Richfield, Utah	WOB 1240	St. Helen, Mich.	KDXU 1450		WKAQ 580 C
Post, Tex.	KLKO 1370	Richland, Wash.	WJMC 1240	St. Hyacinthe, Que.	WMIC 1590		WKVM 1230
Poteau, Okla.	KLJC 1290	Richland, Wis.	KSVG 980	St. Jean, Que.	KCBS 1240		WITA 1140
Potosi, Mo.	KYRO 1280	Richlands, Va.	KALE 960	St. Jerome, Que.	CHRS 1090	San Luis Obispo, Calif.	KDB 1490
Potsdam, N.Y.	WPDW 1470	Richmond, Ind.	WRIC 540	Saint John, N.B.	CHSJ 930		KVCZ 920 M
Pottstown, Pa.	WPAZ 1370	Richmond, Ky.	WKBV 1490 A		CBI 1150	San Marcos, Tex.	KCNV 1470
Pottsville, Pa.	WPAM 1450	Richmond, Va.	WKEY 1340 M	St. John's, Nfld.	CJON 930	San Mateo, Calif.	KOFY 1050
Poughkeepsie, N.Y.	WEOK 1390		WBBL 1480		VOAR 1230	San Rafael, Calif.	KTIM 1510
	WKIP 1450 A		WEZL 1590		VOCM 590	San Saba, Tex.	KBL 1410
Powell, Wyo.	KPOW 1260 M		WEET 1320 N	St. Johnsbury, Vt.	VOWR 800	Santa Ana, Calif.	KWIZ 1480
Poynette, Wis.	WIBU 1240		WMBG 1380 A	St. Joseph, Mich.	WSJM 1400	Santa Barbara, Cal.	KIS 1340 N
Prairie du Chien, Wis.	WPRE 1980		WRNL 910 M	St. Joseph, Mo.	KFEQ 680		KTMS 1250 A-M
Pratt, Kans.	KWSK 1570		WRVA 1140 C		KRES 1550 M	Santa Cruz, Calif.	KSCO 1080
Prescott, Ariz.	KYCA 1490	Richmond Hill, Ont.	WXGI 950	St. Joseph d'Alma, Que.	KUSN 1270	Santa Fe, N.Mex.	KTRC 1400 A
	KLKO 1450	Richmond, W.Va.	WVAB 1280		CFGT 1270		KVSF 1260 C
	KZOK 1340	Ridgecrest, Calif.	KRCK 1360	St. Louis, Mo.	KFOU 850	Santa Maria, Cal.	KCOY 1400
Presque Isle, Me.	WAGM 950		KRKS 1240		KFXO 1120 C	Santa Monica, Cal.	KCS 1580
Preston, Idaho	KPST 1340	Rimouski, Que.	CJBR 900		KSD 550 N	Santa Paula, Calif.	KSPA 1400
Prestonsburg, Ky.	WPRT 960	Rio Piedras, P.R.	WRIO 1320		KSTL 690	Santa Rosa, Calif.	KSRQ 1350
	WDOC 1310		WWWV 1320		KWK 1380		KJAX 1150
Price, Utah	KOAL 1230 M	Ripley, Tenn.	WTRB 1570		KXOK 630	Santurce, P.R.	WIAC 740
Richland, Ala.	WAL 1270	Ripon, Wis.	WCWC 1400		WEW 700 M		WKAQ 580 C
Prince Albert, Sask.	KCBI 900	Riverhead, N.Y.	WRIV 1390		WIL 1430 A	Saranac Lake, N.Y.	WNBZ 1240 A
Prince George, B.C.	KCPG 550	Riverside, Calif.	KPRO 1440	St. Louis Park, Minn.	KRSI 950	Sarasota, Fla.	WSPB 1450 C
Prince Rupert, B.C.	CKFR 1240		KACE 1570		KRSI 950		WSFN 900
Princeton, Ind.	WRAY 1250	Riverton, Wyo.	KWRL 1450 M	St. Mary's, Pa.	WKBI 1400		WRSR 1280
Princeton, Ky.	WPKY 1580	Riviera Beach, Fla.	KHEW 1600	St. Paul, Minn.	KSTP 1500 N		CHOK 1070
Princeton, W.Va.	WLOH 1490 A	Riviere du Loup, Que.	CJFP 1400		KDWB 1590 M	Sarnia, Ont.	CFQC 800
Prineville, Oreg.	KRCO 690	Roanoke, Ala.	WELR 1380	St. Peter, Minn.	KRBI 810	Saskatoon, Sask.	CFM 1380
Prosser, Wash.	WEAN 790 M	Roanoke, Va.	WRIS 1410 M	St. Petersburg, Fla.	WP17 620 A		CKOM 1420
Providence, R.I.	WHIM 1110		WHYE 910		WSUN 620 A		WGHC 920
	WICE 1290		WROV 1240 A	St. Petersburg Beach, Fla.	WILZ 1590	Saugerties, N.Y.	Sault Ste. Marie, Mich.
	WJAR 920 N		WSLS 610 N		CHLO 680		WSOO 1230
	WPRO 630 C	Roanoke Rapids, N.C.	KCRB 1230 M	St. Thomas, Ont.	KSGM 980		Ontario
Provo, Utah	WRIB 1220	Roaring Sprgs., Pa.	WKMC 1370	St. Genevieve, Mo.	WNY 1590		CJIC 1050
	KXKX 1450	Roberval, Que.	CHRL 910	Salamanca, N.Y.	WVLS 1590	Savannah, Ga.	WGPC 1450 M
	KEYY 1450	Robinson, Ill.	WTAY 1570	Salem, Ill.	WSLM 1220		WJIV 900
Pryor, Okla.	KOLS 1570	Rochester, Minn.	KROC 1340 N	Salem, Ind.	WESX 1230 M		WSAV 630 N
Pueblo, Colo.	KDZA 1230		KWEB 1270	Salem, Mass.	KSMO 1340		WSGA 1400
	KAPI 690	Rochester, N.H.	WWNH 930	Salem, Mo.	KSLM 1390 A		WTOC 1290 C
	KFEL 970	Rochester, N.Y.	WBBF 950 M		KBYZ 1490 N	Savannah, Tenn.	WSOK 1230 A
	KCF 1350 A-M		WABE 1180 N	Salem, Va.	KGAY 1430	Sayre, Pa.	WORM 1010
	KCSJ 590		WHEC 1460 C	Salida, Colo.	KVRH 1430 M	Schefferville, Que.	CFKL 1230
	KTUX 1480		WRVM 680	Salina, Kans.	KSAI 1150 M	Schenectady, N.Y.	WGY 810 N
Pulaski, Tenn.	WKSR 1420 A		WSAY 1370	Salinas, Calif.	KDON 1460		WSNY 1240
Pulaski, Va.	WPUV 1580	Rockford, Ill.	WVET 1280		KSBW 1380 M	Scottsbluff, Nebr.	KNEB 960 M
Pullman, Wash.	WKWC 1250		WROK 1440 A	Saline, Mich.	WOIA 1290		KOLT 1320 C
Punxsutawney, Pa.	KOFE 1150	Rock Hill, S.C.	WRRR 330	Salisbury, Md.	WBOC 960	Scottsboro, Ala.	WCRI 1050
Putnam, Conn.	WPCT 1450		WYTC 1150		WIGO 1420 A	Scottsdale, Ariz.	KPSA 1440
Puyallup, Wash.	KAYE 1350	Rockingham, N.C.	WHY 900	Salisbury, N.C.	WSTP 1490 M	Scottsville, Ky.	WLCK 1250
Quanah, Tex.	KOLJ 1150	Rock Island, Ill.	WRHD 1270 C		WSAT 1280 A	Scranton, Pa.	WARM 590 A
Quebec, Que.	CBV 980	Rockland, Maine	WHBF 1450 A	Salmon, Idaho	KSRQ 960		WEIL 630
	CHRC 800	Rockmart, Ga.	WPLK 1220	Salt Lake City, Utah	KALL 910 M		WGBI 910 C
	CJLR 1060	Rock Springs, Wyo.	KVRS 1360 M		KCPX 1320 N		WICK 1400
	CJOC 1340	Rockville, Md.	WINX 1600		KLUB 1320 A	Seaford, Del.	WSCR 1330 N
	CKCY 1280 C	Rockwood, Tenn.	WRKM 580		KNAK 1280	Seattle, Wash.	KAYO 1150
	CKCQ 570	Rocky Ford, Colo.	KAVI 1320		KSL 1160 C		KING 1090 A
Quesnel, B.C.	WCNH 1230 M	Rocky Mount, N.C.	WCEC 810		KSP 1370		KIRO 710 C
Quincy, Fla.	WGEN 1440 A		WEED 1390 A	San Angelo, Tex.	KWHQ 860		KJR 950
Quincy, Ill.	WTAD 930 C		WRMT 1490		KWIC 1570		KJO 1300
Quincy, Mass.	WJDA 1300	Rocky Mount, Va.	WYTI 1570		KTXL 1340		KMO 1000 N
Quincy, Wash.	KPOR 1370	Rogers, Ark.	KAMO 1390		KGP 1420		KTW 1250
Quitman, Ga.	KSPA 490	Rogers City, Mich.	WHA 960	San Antonio, Tex.	KWFR 1260		KXA 770
Racine, Wis.	WRAC 1460	Rogersville, Tenn.	WRGS 1370		KCOR 1350	Searcy, Ark.	KWCB 1300
	WRJN 1400 A	Rolla, Mo.	KTRR 1490		KENS 680 C	Sebring, Fla.	WJCM 960
Radford, Va.	WRAD 1460	Rome, Ga.	WLAQ 1410 A		KUKA 1250		WSEB 1340
Raleigh, N.C.	WKIX 850 A		WRGA 1470 M		KUBO 1310	Sedalia, Mo.	KDRO 1490
	WPTF 680 N	Rome, N.Y.	WRON 1400	San Bernardino, Calif.	KMAC 690 A		KSL 1230
	WSHE 570		WKAL 1450 A		KPEP 1420	Seaguin, Tex.	KWED 1580
	WRAL 1240	Roseburg, Ore.	WRNY 1350		KWFR 1260	Selma, Ala.	WGWC 1340 C
Rapid City, S.Dak.	KOTA 1380	Roseevert, W.Va.	WRN 1450		KWFO 1250		WHBB 1490
	KRSD 920	Roseburg, Ore.	KRNR 1490 C		KWIS 1230		WRWJ 1570
	KEZU 1340		KQEN 1240 A		WOAI 1200		KSLM 1250
	KRTN 1490 A	Rosenberg, Tex.	KFRD 980		KKCC 1350	Seminole, Tex.	WSNW 1150
Ravenswood, W.Va.	WMOV 1360	Rossville, Ga.	KRM 910		KFN 1240	Seneca Township, N.Y.	WSEV 930
Rawlins, Wyo.	KRAL 1240 M	Roswell, N.Mex.	KWSV 1230	Sandersville, Ga.	KRTO 1290 M	Seward, Alaska	KIBH 1340 C-A
Raymond, Wash.	KSDA 1340		KGFL 1400 M	San Diego, Calif.	KCSB 1170	Seymour, Ind.	WJCD 1390
Raymondville, Tex.	KSDX 1240	Rouyn, Que.	KRKM 1400		KFMB 540 N	Seymour, Tex.	KSEY 1230
Rayville, La.	KRIH 950	Roxboro, N.C.	WRXO 1430		KFSO 600 C	Shamokin, Pa.	WISL 1480
Reading, Pa.	WEU 850 A	Royal Oak, Mich.	WEXL 1340		KGB 360	Shamrock, Tex.	KBYC 1580
	WHUM 1240 C	Rumford, Me.	WRUM 790		KSON 1240	Sharon, Pa.	WBYC 790
Redding, Calif.	KRDG 1230 M	Rupert, Idaho	KAYT 970		KSDG 1130	Shawano, Wis.	KSH 1360
	KPAP 1270	Rushton, La.	KRUS 1490	Sandpoint, Idaho	KSTP 1400	Shawinigan, Que.	CKSM 1220
	KSDA 1400	Rusk, Texas	KTLU 1580	Sandusky, Ohio	WLEC 1450 M	Shawnee, Okla.	KGFF 1450 M
	KVCV 600 C	Russell, Kans.	KRSL 990	San Fernando, Calif.	KTRL 1260	Sheboygan, Wis.	WHBL 1330 A
	KVIP 540	Russellville, Ala.	WWWR 920	Sanford, Fla.	WTRR 1400		WKT 950
Red Bluff, Calif.	KBFL 1490	Russellville, Ky.	KXRI 1490		WIOD 1360	Shelby, Mont.	KSEN 1150 M
Red Deer, Alta.	CKRD 850	Rutland, Vt.	WRUS 610	San Francisco, Calif.	WSME 1220	Shelby, N.C.	WOHS 730 M
Redlands, Calif.	KCAL 1410		WHWB 1000		WYFE 1290		WADA 1390
Red Lion, Pa.	WGBB 1440	Sackville, N.B.	WSYB 1380 M		WYGF 1050	Shelbyville, Tenn.	WLJI 1580
Redmond, Oreg.	KPA 1240	Sacramento, Calif.	CBA 1070		KFCR 610 M		KFN 920
Red Wing, Minn.	KCU 1250		KFBA 1320 N		KCB 740 C	Shenandoah, Iowa	KMA 960 A
Redwood Falls, Minn.	KLGR 1490		KFKB 1330 A		KFXA 1100	Sherbrooke, Que.	CHLT 630
Reedsburg, Wis.	WRDB 1400		KGMS 1380 M		KNBC 680 N		CKTS 900
Regina, Sask.	CBK 540		KROY 1240 C		KOBY 1550 M	Sheridan, Wyo.	KWYO 1410 M
	CJME 1300		KXOA 1470		KSAY 1010	Sherman, Tex.	KRRV 910 M
	CKOK 620	Safford, Ariz.	KGLU 1480 A		KSAN 1450		KTXO 1500
	CKRM 980	Saginaw, Mich.	WKNX 1210		KSF 560	Show Low, Ariz.	KVWM 1050
Reidsville, N.C.	WGBF 1800		WSAN 400 N				
	WREM 1220	St. Albans, Vt.	WWSR 1420				
Remsen, N.Y.	WREM 1480	St. Albans, W.Va.	WKLC 1300				
		Ste. Anne de la Pocatiere, Que.	CHGB 1350				

Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.	Location	C.L. Kc. N.A.
Shreveport, La.	KANB 1300 KGIJ 1050 KEEL 710 KENT 1350 M KJOE 480 KOKA 980 KRMD 1340 A KWKH 1130 C	Suffolk, Va.	CHNO 900 WLPF 1450 A KIKS 1310 KSHR Sprgs., Tex. 1250 Summerside, P.E.I. CJRW 240 Summerville, Ga. WGTG 950 Sunter, S.C. WFIG 1290 M WSSC 1340 A	Trinidad, Colo.	WTTM 920 N KCRT 1240 M Troy, Ala. WTBG 970 M Troy, N.Y. WTRY 780 WTRY 980	Wallace, Idaho	KWAL 620 M Wallace, N.C. WLSE 1400 Walla Walla, Wash. KHJT 1320 KUIT 1420 M KTDL 1490 A
Sidney, Mont.	KGKX 1480 M KSID 1340 A Sierra Vista, Ariz. KSIK 1340 A Sikeston, Mo. KSIM 400 Siler City, N.C. WNCB 1570 Siloam Sprgs., Ark. KUOA 1290 Silsbee, Tex. KIKAS 1300 Silver City, N.Mex. KKSIL 1340 C Silver Sprgs., Md. WQMR 1050 Sirex, Ont. KSIK 1340 A Sinton, Tex. KTOD 1050 Sioux City, Iowa KSCJ 1360 A	Sunbury, Pa.	WWSK 1240 C Sunnyside, Wash. KREW 1230 Superior, Neb. KWSN 1600 Superior, Wis. WDMS 710 N WQMN 1320	Truckee, Calif.	KHOE 1400 CICL 600	Walnut Ridge, Ark.	KRLW 1320 Walsenburg, Colo. KFLJ 1380 Walterboro, S.C. WALD 1220 M Waltham, Mass. WCRB 1330 Walton, N.Y. WWTG 1470 Ward Ridge, Fla. WJOE 1570 Ware, Mass. WARE 1250 M
Sioux Falls, S.Dak.	KNNS 620 KTRI 1470 KSLD 1230 KELI 1320 KIRO 1270 KSOO 1140 A	Susanville, Calif.	KSUE 240 Swainsboro, Ga. WJAT 800 Sweetwater, Tenn. WDEH 800 Sweetwater, Tex. KXOX 240 Swift Current, Sask. KTCT 990 Sydney, N.S. CBI 1570 CJCB 1270	Truro, N.S.	KCHS 1400	Warner Robbins, Ga.	WRPB 1350 Warren, Ark. KWRP 860 Warren, Ohio WHHH 1440 Warren, Pa. WWRB 1310 Warrensburg, Mo. WOKK 1450 Warrenton, Mo. KWRE 730 Warrenton, Va. WEER 1570
Sitka, Alaska	KIFW 1230 C-A KSEW 1400 Skowhegan, Maine WGHM 1150 Smithfield, N.C. WMPM 1270 Smiths Falls, Ont. KSNY 1450 M Snyder, Tex. KSRG 1290 So. Secor, N. Mex. KSRG 1290 Soda Sprgs., Idaho KBRV 540 Somerset, Ky. WSFC 1240 M WTLA 480 WVSC 990 Sonora, Calif. KROG 1450 So. Bend, Ind. WNDU 1490 A WJVA 1580 M WSBT 960 C WESO 970 WHLF 1400 A	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Waseo, Calif.	KWSO 1050 Washington, D.C. WGMS 570 WALG 630 A WOL 1450 M WOOB 1340 WWBC 1268 WRC 980 N WTOP 1500 C
Southbridge, Mass.	WESO 970 So. Boston, Va. WHLF 1400 A South Daytona Beach, Fla. WELE 1590 So. Gastonia, N.C. WGS 1420 So. Paris, Me. WKTK 1450 So. Pittsburg, Tenn. WEPG 910 So. St. Paul, Minn. WISK 630 M So. Williamsport, Pa. WMPF 1450 WMO 1230 WMSO 1050 WCOW 1290 WTHE 1420 M WORD 910 N WSPA 950 C WYAN 1240 KGA 1510 A KLYK 1230 KPEG 1380 KHQ 590 N KNEW 790 M KREM 970 C KKLY 920 C KFCB 1330 KBRS 1340 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Southbridge, Mass.	WESO 970 So. Boston, Va. WHLF 1400 A South Daytona Beach, Fla. WELE 1590 So. Gastonia, N.C. WGS 1420 So. Paris, Me. WKTK 1450 So. Pittsburg, Tenn. WEPG 910 So. St. Paul, Minn. WISK 630 M So. Williamsport, Pa. WMPF 1450 WMO 1230 WMSO 1050 WCOW 1290 WTHE 1420 M WORD 910 N WSPA 950 C WYAN 1240 KGA 1510 A KLYK 1230 KPEG 1380 KHQ 590 N KNEW 790 M KREM 970 C KKLY 920 C KFCB 1330 KBRS 1340 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Spokane, Wash.	KLYK 1230 KPEG 1380 KHQ 590 N KNEW 790 M KREM 970 C KKLY 920 C KFCB 1330 KBRS 1340 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springdale, Ark.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Ill.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Mass.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Mo.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Ohio	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Oreg.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Tenn.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 1340 WJPA 1450 M
Springfield, Vt.	KBRB 1330 A WCVS 1450 A-M WMAY 970 N WTAX 1220 WBEA 1050 WYAN 560 C WMAS 1450 M WSPR 1270 KGBB 1260 N KICK 340 KITS 1240 C KWTO 560 A WVIZ 1340 A WBL 1050 KEED 1600 WDBL 1590 WCFR 1480 KBSE 1480 WVIZ 1470 WSTC 1400 A KDWT 1400 WRGR 1490 WSSO 1230 WMAJ 1450 M WNS 1420 WSD 1440 WDBM 550 WTON 1240 A WAF 900 KSTV 1510 KGEK 1230 KOLR 1490 WBR 1240 WSTV 1340 M WSP 1010 WBL 930 WAVN 1220 KSPI 780 KJAY 1280 KRAK 1440 KSTN 1420 KWG 1230 A-M KAYL 990 CJCS 1240 WIZZ 1250 WYPO 840 WSTU 1450 M WBR 1240 WSTV 1340 M KWAK 1240 M CKSO 790 CFBB 550	Tahtahquah, Okla.	WJHS 1500 TNMUZ 1230 M Tallahassee, Fla. WMEN 1330 WRFB 1580 WTAL 1270 Tallassee, Ala. WTLS 1300 WTNT 1450 A-M-C	Tulsa, Tex.	KTUE 1260 Tulahoma, Tenn. WTLA 740 Tulsa, Okla. KAKC 970 KOME 1300 KRMG 740 KTDL 1430 C KVoo 1170 N KFMJ 1050 KGO 580 M WTUP 1490 A KTUR 390 WJRD 1150 WACT 1420 WNPT 1280 WTUG 790 WTEG 1230 M WYNA 1590 WABA 580 KTFI 1270 N KLIX 1310 M KEEP 1450	Washington, Ga.	WKLE 1370 Washington, Ind. WAMW 1580 Washington, N.J. WCRV 1580 Washington, N.C. WOOB 134

Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.
Muscatine	KWPC-FM	99.7	E. Lansing	WKAR-FM	*90.5	New York	WABC-FM	95.5	Frempont	WFRO-FM	99.3
Sturgeon Lake	KAYL-FM	101.5		WSWM	99.1		WBAI	99.5	Hamilton	WQMS	96.7
Waverly	KWAR	89.1	Flint	WFBE	*95.1		WBFM	101.9		WUOH	103.5
KANSAS											
Emporia	KSTE	*88.7	Highland Pk.	WFRS	92.5		WBBS-FM	101.9	Kent	WKSU-FM	*88.1
Kansas City	KCJC	98.1	Jackson	WJFS-FM	93.7		WEVU-FM	97.7	Lancaster	WHOK-FM	95.5
Lawrence	KANU	*91.5	Kalamazoo	WLAV-FM	96.9		WFUT	*90.7	Lima	WIMM-FM	102.1
Manhattan	KSDB-FM	*88.1	Oak Park	WHPR	*88.1		WHOM-FM	92.3	Marion	WMRN-FM	106.9
Newton	KIRG-FM	92.1	Royal Oak	WQIX	94.1		WKCR-FM	*89.9	Middletown	WPFB-FM	105.9
Ottawa	KTJO-FM	*88.1		WMCR	*102.1		WNCN	103.3	Mt. Vernon	WMVO-FM	93.7
Wichita	KFH-FM	100.3		WDMO	95.5		WNEW-FM	102.7	Newark	WCLT-FM	100.3
	KMUW	*89.1	Saginaw	WOAK	98.3		WNYC-FM	93.9	Oxford	WUUB	*88.5
			Sturgis	WOMC	104.3		WNYE	95.1		WOXE	97.7
				WSAM-FM	98.3		WOR-FM	98.7	Portsmouth	WPAY-FM	104.1
				WSTR-FM	103.1		WQXR-FM	96.3	Salem	WSOM-FM	105.1
							WNBC-FM	97.1	Sandusky	WLEC-FM	102.7
							WRFM	105.1	Springfield	WBLV-FM	103.9
KENTUCKY											
Ashland	WCMJ-FM	93.7	Mankato	KYSM-FM	103.5	Niagara Falls	WHLD-FM	98.5	Steubenville	WSTV-FM	103.5
Central City	WNES-FM	101.9	Minneapolis	KTIS-FM	*98.5	Olean	WHDF-FM	92.3	Toledo	WSPD-FM	101.1
Fulton	WFUL-FM	104.9		KWFM	97.1	Patchogue	WALK-FM	95.7		WTDJ	92.5
Hazard	WKIC-FM	95.3		WLOL-FM	99.5		WPAC-FM	106.1		WTDS	*91.1
Henderson	WSON-FM	99.5	St. Cloud	KFAM-FM	104.7	Peekskill	WLNA-FM	100.7		WTOT-FM	104.7
Hopkinsville	WRLX	98.7				Poughkeepsie	WKIP-FM	104.7	Wartert	WTRT	99.9
Lexington	WBKY	*91.3				Rochester	WHFM	98.9	Wooster	WWST-FM	104.5
Louisville	WLAP-FM	94.5				Schenectady	WROC-FM	97.9	Youngstown	WKBN-FM	98.9
	WFPK	*91.9	Jackson	WJDX-FM	102.9	Schenectady	WRER	95.1		WBBW-FM	93.3
	WFPL	*89.3	Meridian	WMMI	*88.1	Syracuse	WSPE	*88.1		WRED	101.1
	WLVJ	93.9					WAER	*88.1			
Madisonville	WFMW-FM	93.9					WDDS-FM	93.1	OKLAHOMA		
Owensboro	WNGO-FM	94.7					WONO	100.9	Durant	KSEO-FM	107.3
	WOMI-FM	92.5	Clayton	KFUO-FM	99.1	Troy	WYSR-FM	94.5	Norman	WNAD-FM	*90.9
	WVJS-FM	96.1	Johnlin	WMBH-FM	96.1	Utica	WFLY	92.3	Oklaoma City	KOKH	*88.9
Paducah	WPAD-FM	96.9	Kansas City	KCMO-FM	94.9	Wethersfield	WRPI	91.5		KEFM	94.7
	WKYB-FM	93.3		KOMC	96.3	White Plains	WRUN-FM	105.7		KYFM	98.9
LOUISIANA											
Alexandria	KALB-FM	96.9		KCUR-FM	98.3		WRRJ	107.7	Shawnee	KBCG	*89.9
Baton Rouge	WJBO-FM	98.1		KXTR	96.5		WFAS-FM	103.9	Stillwater	KAMC-FM	*91.7
Monroe	KMBL-FM	104.1	Kennett	KBOA-FM	98.9				Tulsa	KSPI-FM	93.9
New Orleans	WBEH	89.3	Poplar Bluff	KWOC-FM	94.5					KWGS	90.5
	WDSU-FM	105.3	St. Louis	KCFM	93.7					KOCW	97.5
	WRCM	97.1	Springfield	KLSH	*91.5						
Shreveport	WMMT	95.7	West Plains	KTSF-FM	93.7	NORTH CAROLINA					
	KRMD-FM	96.5		KWPM-FM	93.9	Albamar	WABZ-FM	100.9	Eugene	KRYM	*91.9
	KBCJ-FM	96.5				Asheboro	WGWR-FM	92.3		KEED-FM	93.1
	KWKH-FM	94.5				Asheville	WLOS-FM	104.3		KUGN-FM	99.1
						Burlington	WBBB-FM	101.1		KWAX	*91.9
							WFNS-FM	93.9		KGPD	96.9
						Chapel Hill	WUNC	*91.5		KBOY-FM	65.3
						Charlotte	WSOC-FM	103.5		KTEC	*88.1
						Clingman's Pk.	WMTT	106.9		KEX-FM	92.3
						Durham	WDNC-FM	105.1	Grants Pass	KOIN-FM	101.1
						Elkin	WFIM-FM	100.9	Medford	KPFM	97.1
						Fayetteville	WFNC-FM	98.1	Oretech	KPOJ-FM	98.7
						Forest City	WBBQ-FM	93.3	Portland	KQFM	100.3
						Gastonia	WGNC-FM	101.9		KRRC	*89.3
						Greensboro	WGEQ	96.9			
						Greensboro	WGFS	*89.9			
							WMDE	98.7			
							WMDS	*81.3			
							WHNC-FM	92.5			
							WHKP-FM	102.5			
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RHODE ISLAND			TEXAS			VIRGINIA			WEST VIRGINIA		
Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.
Cranston	WLOV	99.9	Amarillo	KGNC-FM	93.1	Arlington	WARL-FM	105.1	Besley	WBKW	99.5
Providence	WPJB-FM	105.1	Austin	KHFI	98.3	Charlottesville	WINA-FM	95.3	Charleston	WKAZ-FM	97.5
	WPFM	95.5		KAZZ	95.5		WTJU	91.3	Huntington	WKEE-FM	100.5
	WPRO-FM	92.3	Beaumont	KRIC-FM	97.5	Crewe	WSVS-FM	104.7	Martinsburg	WEPM-FM	94.3
	WXON	101.5	Brownwood	KHPG	88.1	Harrisonburg	WEMC	91.7	Morgantown	WJAF-FM	99.3
Woonsocket	WWON-FM	106.3	Celburne	KCLE-FM	94.9		WSVA-FM	100.7	Oak Hill	WOAY-FM	94.1
			Corpus Christi	KDMC	95.5	Lynchburg	WWOD-FM	100.1	Parkersburg	WAAM-FM	106.5
			Dallas	KIXL-FM	104.5	Martinsville	WMVA-FM	96.3	Wheeling	WKWK-FM	97.3
				KNER	*88.1	Newport News	WGH-FM	97.3		WVVA-FM	98.7
				KRLD-FM	92.5	Norfolk	WMTI	*91.5			
Anderson	WCAC	101.1		WRR-FM	101.1		WVRC	102.5			
Charleston	WCSC-FM	96.9		KVTT	106.7		WYFI-FM	99.7			
	WTMA-FM	95.1	Denton	KDNT-FM	98.1	Richmond	WFOS	98.1	Appleton	WLFM	*91.1
Columbia	WCOS-FM	97.9	El Paso	KVOF-FM	98.5		WRFK	91.1	Chilton	WHKW	*89.3
	WNOK-FM	104.7		KHMS	94.7		WRVA-FM	94.5	Colfax	WHWC	*88.3
	WUSC-FM	98.9	Ft. Worth	WBAP-FM	96.3		WRNL-FM	102.1	Delafield	WHAD	*90.7
Dillon	WDSC-FM	92.9		KFJZ-FM	97.1	Roanoke	WDBJ-FM	94.9	Eau Claire	WIAL	*94.1
Greenville	WESC-FM	92.5	Gainesville	KGAF-FM	94.5		WROV-FM	103.7	Fort Atkinson	WFAW	107.3
	WFBC-FM	93.7	Houston	KHGM	102.9	South Norfolk	WSLS-FM	99.1	Greenfield Twp.	WWCF	94.9
Rock Hill	WRHI-FM	93.5		KHUL	95.7	Staunton	WFOF	90.5	Highland	WHHI	91.3
Seneca	WSNW-FM	98.1		KFMK	97.9	Williamsburg	WAFC-FM	93.3	Highland Twp.	WHSA	*89.9
Spartanburg	WSPA-FM	98.9		KRBE	104.1	Winchester	WCWM	99.1	Janesville	WCLO-FM	99.9
				KTRH-FM	101.1	Woodbridge	WRFL	92.5	La Crosse	WHLA	*90.3
			Lubbock	KUHF	*91.3		WBVA	105.9	Madison	WHA-FM	*88.7
				KRRK-FM	93.7					WISZ-FM	98.1
				KBFM	96.3					WMFM	104.1
Bristol	WOPI-FM	96.9	Midland	KNFM	92.3	Bellingham	KGMI	92.9		WVFB-FM	102.5
Chattanooga	WDDC-FM	96.5	Plainview	KHBL	*88.1	Cheney	KEWC-FM	*89.9	Merrill	WLIN	100.7
Greeneville	WGRV-FM	94.9	Port Arthur	KFMP	93.3	Seattle	KING-FM	98.1	Milwaukee	WFRM	96.5
Jackson	WTJS-FM	104.1	San Antonio	KISS	99.5		KETO-FM	101.5		WQFM	94.3
Johnson City	WJHL-FM	100.7		KEEZ	97.3		KIRO-FM	100.7		WTMJ-FM	93.1
Kingsport	WKPT-FM	98.5		KONO-FM	92.9		KISW	99.9	Monroe	WEKZ-FM	93.7
Knoxville	WBR-FM	93.3	Texarkana	KCMC-FM	98.1		KMCS	98.9	Racine	WRJN-FM	100.7
	WICS	*91.1	Waco	KEFC	95.5		KUOW	94.9	Rice Lake	WJMC-FM	96.3
	WUOT	*91.9	Waxahachie	KBEC-FM	93.5		KPCS	90.9	Sparta	WCOW-FM	97.1
Memphis	WMCF	99.7				Spokane	KLAY-FM	106.3	Wausau	WHRM	*91.9
	WMPS-FM	97.1				Tacoma	KTNT-FM	97.3	West Bend	WBKV-FM	92.5
	WQMM	95.5					KTOY	*91.7	Wisc. Rapids	WFHR-FM	103.3
Nashville	WFMB	105.9	Ephraim	KEPH	*88.9		KTWR	103.9			
	WSIX-FM	97.5	Logan	KVSC	*88.1						
Abilene	KACC-FM	*91.1	Salt Lake City	KCPX-FM	98.7						
				KSL-FM	100.3						

Canadian FM Stations

Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.	Location	C.L.	Mc.
Brantford, Ont.	CKPC-FM	92.1		CKLK-FM	99.5	Ottawa, Ont.	CBO-FM	103.3		CFRB-FM	99.9
Cornwall, Ont.	CJSS-FM	104.5		CKWS-FM	96.3		CFRA-FM	93.9		CHFI-FM	98.1
Edmonton, Alta.	CGRN-FM	100.3	Kitchener, Ont.	CKCR-FM	96.7	Quebec, Que.	CHRC-FM	98.1		CJRT-FM	91.1
	CJCA-FM	99.5	Lethbridge, Alta.	CHEC-FM	100.9	Rimouski, Que.	CJBR-FM	101.5	Vancouver, B.C.	CBU-FM	105.7
	CKUA-FM	98.1	London, Ont.	CFPL-FM	95.9	St. Catharines, Ont.			Victoria, B.C.	CKVL-FM	96.9
Ft. William, Ont.	CKPR-FM	94.3	Montreal, Que.	CBM-FM	100.7	Sydney, N.S.	CKTB-FM	97.7	Windsor, Ont.	CKLA-FM	98.5
Halifax, N.S.	CHNS-FM	96.1		CFCE-FM	106.5	Timmins, Ont.	CJCB-FM	94.9		CKLW-FM	93.9
Kingston, Ont.	CFRC-FM	91.9	Oshawa, Ont.	CKLB-FM	93.5	Toronto, Ont.	CKGB-FM	94.5		CJOB-FM	103.1
							CBC-FM	99.1			

United States Television Stations

(Territories and possessions follow states). Chan., channel number; asterisk (*) indicates educational station.

Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.
ALABAMA			CALIFORNIA			CONNECTICUT			Columbus		
Andalusia	WAIG	*2	Bakersfield	KBAK-TV	29	Bridgeport	WICC-TV	43		WRBL-TV	3
Birmingham	WAPI-TV	13		KERO-TV	10	Hartford	WTIC-TV	3	Macon	WTVM	9
	WBIQ	*10		KLYD-TV	17		WHCT	18	Savannah	WSAV-TV	3
	WBRC-TV	6	Chico	KHSL-TV	12	New Britain	WHNB-TV	30	Thomasville	WTCC-TV	11
Decatur	WMSL-TV	23	El Centro	XEM-TV	3	New Haven	WNHC-TV	8		WCTV	6
Dothan	WTVY	9	Eureka	KIEM-TV	3	Waterbury	WATR-TV	53			
Florence	WOWI	15		KVIQ-TV	12						
Huntsville	WAFG-TV	31	Fresno	KFRE-TV	42						
Mobile	WALA-TV	10		KJEO	47						
	WKRQ-TV	5		KMJ-TV	24						
Montgomery	WCOV-TV	20	Los Angeles	KABC-TV	7	Washington	WMAL-TV	7			
	WSFA-TV	12		KCOF	13		WRC-TV	4	Hilo	KHBC-TV	9
Munford	WCIG	*7		KHJ-TV	9		WTOP-TV	9	Honolulu	KGMB-TV	13
Selma	WSLA	8		KNXT	2		WTTG	5		KONA	2
				KRCA	4				Wailuku	KULA-TV	4
				KTLL	5					KMAU	3
				KTTV	11					KALA	7
ALASKA				KTVU	2					KMVI-TV	12
Anchorage	KENI-TV	2	Oakland	KVPI-TV	7	Daytona Beach	WESH-TV	2			
	KTVA	11	Redding	KXTV	10	Fort Myers	WINK-TV	11	Boise	KBOI	2
Fairbanks	KFAR-TV	2	Sacramento	KCRA-TV	7	Gainesville	WUFT	*5		KTUV	7
	KTVF	11		KVIE	*6	Jacksonville	WFGA-TV	12	Idaho Falls	KID-TV	3
Juneau	KINY-TV	8		KSBB-TV	8		WJCT	*7	Lewiston	KLEW-TV	3
			Salinas	KFSB-TV	8		WCKT	7	Nampa	KCIX-TV	6
			San Diego	KFSD-TV	10	Miami	WPST-TV	10	Pocatello	KTLE	6
			(Tijuana, Mex.)	XETV	*6		WTHS-TV	*2	Twin Falls	KLIX-TV	11
Phoenix	KOOL-TV	10	San Francisco	KGO-TV	7		WTVJ	4			
	KPHO-TV	15		KPIX	*5	Orlando	WDBO-TV	6			
	KTVK	3		KQED	*8		WLOP-TV	7			
	KVAR	12		KRON-TV	9	Palm Beach	WPTV	9	Champaign	WCIA	3
Tucson	KGUN-TV	9	San Jose	KNTV	11	Panama City	WJDM-TV	7		WCHU	33
	KOLD-TV	13	San Luis Obispo	KSBJ-TV	6	Pensacola	WEAR-TV	3	Chicago	WBMM-TV	22
	KVOA-TV	4	Santa Barbara	KEY-TV	3	St. Petersburg	WSUN-TV	38		WBKB	7
	KUAT	*6	Stockton	KOVR	13	Tampa	WFLA-TV	8		WGN-TV	9
Yuma	KIVA	11					WEDU	*3		WNBQ	5
							WTVT	13		WTTW	*11
						W. Palm Beach	WEAT-TV	12	Danville	WDAN-TV	24
ARKANSAS									Decatur	WTVP	17
El Dorado	KTVF	10	Colorado Springs	KKTV	11				Harrisburg	WSIL-TV	3
Ft. Smith	KFSA-TV	5		KRDO-TV	13				La Salle	WEEQ-TV	35
Little Rock	KARK-TV	4	Denver	KBTU	7				Peoria	WEEK-TV	43
	KATH	11		KLZ-TV	4	Albany	WALB-TV	10		WMBD	31
	KATV	7		KOA-TV	4	Athens	WGTV	*8		WTVH	19
	KATV	7		KRMA-TV	*6	Atlanta	WAGA-TV	5	Quincy	WGM-FM	10
Texarkana	KCMC-TV	6		KTVR	2		WSB-TV	2	Rockford	WRFX-TV	13
				KREX-TV	5		WETV	*30		WTVO	39
			Grand Junction	KREY-TV	10		WLW-A	11	Rock Island	WHBF-TV	4
			Montrose	KCSJ-TV	5	Augusta	WJBF	6	Springfield	WICS	20
			Pueblo				WRDW-TV	12	Urbana	WILL-TV	*12

[illegible]

Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.
Harrisonburg	WSVA-TV	3		KIRO-TV	7	Huntington	WHTN-TV	13	Milwaukee	WISN-TV	12
Lynchburg	WLVA-TV	13		KOMO-TV	7		WSAZ-TV	3		WMVS-TV	*10
Norfolk	WTAR-TV	3	Spokane	KHQ-TV	6	Oak Hill	WOAY-TV	4		WTMJ-TV	4
Petersburg	WXEX-TV	8		KREM-TV	2	Parkersburg	WTAP-TV	15		WXIX	18
Portsmouth	WAVY-TV	10		KXLY-TV	4	Wheeling	WTRF-TV	7	Wausau	WSAU-TV	7
Richmond	WRVA-TV	12	Tacoma	KTNT-TV	11				Whitefish Bay	WITI-TV	6
	WTVR	6		KREC-TV	56	WISCONSIN					
Roanoke	WDBJ-TV	7	Yakima	KTNW	13		WEAU-TV	13	WYOMING		
	WLSL-TV	10	Walla Walla	KIMA-TV	23	Eau Claire	WEAU-TV	13		KTWO-TV	2
WASHINGTON				KNDQ-TV	23	Green Bay	WBAY-TV	2	Casper	KTWO-TV	2
Bellingham	KVOS-TV	12	WEST VIRGINIA				WFRV	5	Cheney	KFCB-TV	5
Ephrata	KBAS-TV	16		KNSB	22	La Crosse	WKBT	8	Riverton	KWRB-TV	10
Pasco	KEPR-TV	19	Bluefield	WHIS-TV	6	Madison	WHA-TV	*21	PUERTO RICO		
Seattle	KCTS-TV	*9	Charleston	WCHS-TV	8		WISC-TV	3			
	KING-TV	5	Clarksburg	WBOY-TV	12		WKOW-TV	27	Aquidilla	WOLE-TV	12
						Marinette	WMTV	33	Caguas	WKBM-TV	11
							WMBV-TV	11			

Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.	Location	C.L.	Chan.
ALBERTA			MANITOBA			ONTARIO			QUEBEC		
Calgary	CHCT-TV	2	Brandon	CKX-TV	5	Barrie	CKVR-TV	3	Clermont	CFCV-TV-I	75
Edmonton	CFRN-TV	3	Winnipeg	CBWT	3	Elk Lake	CFCL-TV-2	2	Estouart	CJES-TV-I	70
Lethbridge	CJLH-TV	7				Elliot Lake	CKSO-TV-I	3	Jonquiere	CKRS-TV	12
Medicine Hat	CHAT-TV	6	NEW BRUNSWICK			Hamilton	CHCH-TV	11	Matane	CKBL-TV	9
Red Deer	CHCA-TV	6	Moncton	CKCW-TV	11	Kapuskasing	CFCL-TV-I	3	Montreal	CBMT	2
BRITISH COLUMBIA				CBFT	2	Kenora	CBWT	2		CBMT	6
Dawson Creek	CJDC-TV	5	Saint John	CHSJ-TV	4	Kingston	CKWS-TV	11	New Carlisle	CHAU-TV	5
Kamloops	CFCR-TV	4	NEWFOUNDLAND			Kitchener	CKGO-TV	13	Quebec	CFQM-TV	4
Kelowna	CHBC-TV	2	Argenteia	CJOX-TV	10	London	CFPL-TV	10		CKMI-TV	5
	CHGP-TV-I	72	Corner Brook	CBYT	5	North Bay	CKGN-TV	10	Rimouski	CJBR-TV	3
Oliver	CHBC-TV-3	8	Grand Falls	CJCN-TV	4	Peterborough	CHEX-TV	12	Rouyn	CKRN-TV	4
Penticton	CHBC-TV	13	St. John's	CJON-TV	6	Ottawa	CBQF	2	Sherbrooke	CHLT-TV	7
Vancouver	CBUT	2	Stephenville	CFSN-TV	8	Port Arthur	CFCL-TV	2	Three Rivers	CKTM-TV	13
Vernon	CHBC-TV	7	NOVA SCOTIA			Sault Ste. Marie	CJIO-TV	2			
Victoria	CHEK-TV	6				Sudbury	CKSO-TV	5	SASKATCHEWAN		
LABRADOR			Halifax	CBHT	3	Timmins	CFCL-TV	6	Moose Jaw	CHAB-TV	4
Goose Bay	CFLA-TV	8	Inverness	CJCB-TV-I	6	Toronto	CBTL	6	Prince Albert	CKBI-TV	5
			Liverpool	CBHT-I	12	Windsor	CKLW-TV	9	Regina	CKCK-TV	2
			New Glasgow	CFCY-TV-I	7	Winham	CKNX-TV	8	Saskatoon	CFQC-TV	8
			Shelburne	CBHT-2	8	PRINCE EDWARD ISLAND			Swift Current	CFJB-TV	5
			Sydney	CJCB-TV	4				Yorkton	CKOS-TV	3
			Yarmouth	CBHT-3	11	Charlottetown	CFCY-TV	13			

World-Wide Short-Wave Stations

Most international broadcasting is done within frequency limits agreed upon at international conventions. These frequency ranges are listed here, at the right, expressed both in frequency and by meter bands (wave-length).

Reception in the various bands varies according to the time of day and season of the year. Reception in the 60, 49 and 41 meter bands is best at night during the winter months. Reception in the 31 and 25 M. bands is best at night, but all year. Reception in the 19, 16, 13 and 11 M. bands is best during the day, also at night during the summer in the 16 and 19 M. bands.

Abbr.: AIR—All India Radio; RAI—Radiotelevisione Italiana; RTF—Radiodiffusion Television Francaise; VOA—Voice of America; RFE—Radio Free Europe. •denotes stations beaming evening (U.S.) broadcasts to the U.S., †morning or afternoon broadcasts.

METER BANDS

4750 to 4900	5060 kc/s (60 meter band)
5950 to 6200	49 meter band
7100 to 7300	41 meter band
9500 to 9775	31 meter band
11700 to 11975	25 meter band
15100 to 15450	19 meter band
17700 to 17900	16 meter band
21450 to 21750	13 meter band
25600 to 26100	11 meter band

Kcs.	Call and Location
4630	HGGBI, Quito, Ecu.
4765	HJEF, Cali, Col.
4770	ELWA, Monrovia, Lib.
4775	YVMW, Ponto Fiji, Ven.
4775	Libreville, Gabon Rep.
4780	YVLA, Valencia, Ven.
4790	YVQN, Puerto La Cruz, Ven.
4795	Rangoon, Burma
4805	ZYS8, Manaus, Braz.
4810	YVMA, Maracaibo, Ven.
4830	YVOA, San Cristobal, Ven.
4835	HJKE, Bogota, Col.
4840	Laureno Marques, Moz.
4840	YVOI, Valera, Ven.
4845	HJGF, Bucaramanga, Col.
4850	YVMS, Barquisimeto, Ven.
4870	Cotonou, Dahomey Rep.
4880	YVKF, Caracas, Ven.
4893	Dakar, Mali Fed.
4895	PRF6, Manaus, Braz.
4898	HJQG, Barranquilla, Col.
4900	HJGF, Bogota, Col.
4905	HRAQ, Puerto Cortes, Hon.
4910	HCIMI, Quito, Ecu.
4910	Conakry, Guinea
4915	Acera, Ghana
4920	VLM4, Brisbane, Aus.
4920	YVKR, Caracas, Ven.
4930	HCIR, Quito, Ecu.
4935	HJLF, Ibague, Col.
4940	Abidjan, Ivory Coast
4940	YVMO, Barquisimeto, Ven.

Kcs.	Call and Location
4945	HJCV, Bogota, Col.
4945	Paradys, So. Afr.
4950	Dakar, Mali Fed.
4950	YVMM, Coro, Ven.
4955	CR6RZ, Luanda, Ang.
4960	YVQA, Cumana, Ven.
4970	YVLK, Caracas, Ven.
4975	Yaounde, Cameroun
4990	Lagos, Nigeria
4990	YVMQ, Barquisimeto, Ven.
5010	HCRGX, Quito, Ecu.
5010	St. George, Grenada, B.W.I.
5020	HJFW, Manizales, Col.
5020	Niamey, Niger Rep.
5030	YVKM, Caracas, Ven.
5040	YVMA, Maracaibo, Ven.
5045	Lome, Togo
5050	YVKD, Caracas, Ven.
5075	HJGC, Bogota, Col.
5078	HRN, Tegucigalpa, Hond.
5080	Moscow, U.S.S.R.
5082	TGNA, Guatemala, Guat.
5084	YVQI, Puerto Limon, C. R.
5086	HJGF, Bogota, Col.
5085	YVNW, Granada, Nic.
5088	TGAR, Guatemala, Guat.
5081	Georgetown, Br. Guiana
5082	4VB, Port-au-Prince, Haiti
5090	Andorra, Andorra
5090	TGJA, Guatemala, Guat.
5095	Fort-de-France, Mart.
6002	4VEC, Cap Haitien, Haiti
6005	RIAS, Berlin, Ger.
6006	THBG, San Jose, C. R.
6010	XEOL, Mexico City, Mexico
6015	PRA8, Recife, Braz.

Kcs.	Call and Location
6020	Amman, Jordan
6020	Kiev, Ukrainian S.S.R.
6025	Kuala Lumpur, Malaya
6025	Hilversum, Neth.
6030	Baghdad, Iraq
6035	Rangoon, Burma
6035	HRTL, Tegucigalpa, Hond.
6037	TIFC, San Jose, C. R.
6037	Monte Carlo, Mon.
6040	HJLB, Ibague, Col.
6045	YDF, Djakarta, Indon.
6045	HOU3I, David, Pan.
6050	HCBJ, Quito, Ecu.
6050	BBC, London, Eng.
6055	HJEX, Cali, Col.
6055	JOZ2, Tokyo, Japan
6060	RAI, Caltanissetta, It.
6065	XEXG, Leon, Mex.
6065	Horbj, Sweden
6070	Sofia, Bulgaria
6070	BBC, London, Eng.
6075	Norden, Ger.
6080	ZL7, Wellington, N.Z.
6082	OXAXZ, Lima, Peru
6085	Munich, Ger.
6090	VLI6, Sydney, Aus.
6090	Luxembourg, Lux.
6090	XECMT, C. El Mante, Mex.
6095	ZYB7, Sao Paulo, Braz.
6100	VOA, Munich, Ger.
6100	Belgrade, Yugo.
6103	Peking, China
6105	XEQM, Merida, Mex.
6105	Tunis, Tunisia
6110	BBC, London, Eng.
6115	ZYC7, Rio de Jan., Braz.
6115	Khabarovsk, U.S.S.R.
6120	LRXI, Buenos Aires

Kcs.	Call and Location
6120	BBC, Limassol, Cyprus
6130	Port Moresby, New Guinea
6130	Madrid, Spain •
6135	HRMF, La Ceiba, Hond.
6135	Papeete, Tahiti
6135	Singapore, Sing.
6140	HCOV5, Azogues, Ecu.
6140	VLW6, Perth, Aus.
6145	Algiers, Algeria
6147	PRL9, Rio de Jan., Braz.
6150	VLR6, Melbourne, Aus.
6150	BBC, London, Eng.
6155	4VWA, Cap Haitien, Haiti
6155	VOA, Salonika, Greece
6160	HJKJ, Bogota, Col.
6160	FEN, Tokyo, Japan
6165	HER3, Bern, Switz. •
6165	XEWW, Mexico City, Mex.
6165	Saigon, Vietnam
6170	BBC, Limassol, Cyprus
6170	Cayenne, Fr. Guiana
6175	RTF, Paris, France
6180	BBC, London, England
6185	HJCT, Bogota, Col.
6190	VOA, Munich, Ger.
6190	HVJ, Vatican City
6195	HJEZ, Cali, Col.
6195	HRD2, La Ceiba, Hond.
6195	Pyongyang, N. Korea
6200	H12LR, C. Trujillo, D.R.
6200	4VHW, Port-au-Prince, Haiti
6208	TGHC, Guatemala, Guat.
6215	Pyongyang, N. Korea
6225	Peking, China
6305	Andorra, Andorra
6327	COCF, Havana, Cuba
6345	Ulan Bator, Mong.

Kcs. Call and Location

6973 Lisbon, Port.
6990 BBC, Lissol, Cyprus
7105 Madrid, Spain
7110 VOA, Colombo, Ceylon
7110 BBC, London, England
7115 Rabat, Morocco
7115 RFE, Germ.
7128 BBC, London, England
7210 BBC, Singapore
7215 Warsaw, Poland
7240 Monte Carlo, Monaco
7145 RFE, Ger.
7150 Khabarovsk, U.S.S.R.
7160 RTF, Paris, France
7160 VOA, Tangier, Mor.
7165 RFE, Germ.
7170 Algiers, Alg.
7180 Baghdad, Iraq
7185 BBC, London, Eng.
7200 BBC, London, Eng.
7200 R. Malaya, Sing.
7200 Omdurman, Sudan
7205 VOA, Salonika, Gr.
7210 BBC, London, Eng.
7210 Dakar, Mali Fed.
7210 Khabarovsk, U.S.S.R.
7220 VLD, Melbourne, Aus.
7220 Budapest, Hung.
7230 BBC, London, Eng.
7235 Taipei, Taiwan, China
7235 VOA, Munich, Ger.
7240 RTF, Paris, France
7250 BBC, London, Eng.
7255 Sofia, Bulg.
7260 Saigon, Vietnam
7265 Motala, Sweden
7270 Magadan, U.S.S.R.
7275 RAI, Rome, It.
7280 Teheran, Iran
7280 HVJ, Vat. City
7285 Ankara, Turk.
7290 RAI, Rome, It.
7295 Makassar, Celebes
7295 RFE, Ger.
7300 BBC, London, Eng.
7398 Damascus, U.A.R.
7505 Peking, China
7650 YNMS, Leon, Nic.
7670 Sofia, Bulg.
7680 Tirana, Alb.
8002 Beirut, Leb.
8005 HCIC3, Karuma, Ecua.
9009 Tel Aviv, Israel
9026 COBZ, Havana, Cuba
9065 Peking, China
9210 Leopoldville, Congo
9360 Madrid, Spain
9363 COBC, Havana, Cuba
9368 Alma Ata, Kazakh S.S.R.
9385 Leopoldville, Congo
9410 BBC, London, Eng.
9440 CP38, La Paz, Bol.
9458 Peking, China
9500 XEWW, Mexico City, Mex.

9500 Magadan, U.S.S.R.
9500 Moscow, U.S.S.R.
9530 PRB22, Sao Paulo, Braz.
9550 Rabat, Mor.
9505 HOLA, Colon, Pan.
9510 Peking, China
9510 VOA, Tangier, Mor.
9515 RAI, Caltanissetta, It.
9515 Ankara, Turkey
9520 Colombo, Ceylon
9520 Copenhagen, Den.
9520 VOA, Salonika, Gr.
9520 OAX8E, Iquitos, Peru
9523 Parady's, S. Afr.
9525 BBC, London, Eng.
9525 JOB9, Tokyo, Japan
9525 Warsaw, Poland
9530 COCO, Havana, Cuba
9530 VOA, Munich, Ger.
9530 AIR, Delhi, India
9530 VOA, Courier, Rhodes
9530 VYMZ, Maracaibo, Ven.
9535 Lagos, Nigeria
9535 VOA, Manila, P.I.
9535 HER4, Bern, Switz.
9540 ZL2, Wellington, N.Z.
9540 Omdurman, Sudan
9545 ZY543, Curitiba, Braz.
9545 HED5, Bern, Switz.
9550 Prague, Czech.
9550 AIR, Bombay, India
9550 OAX1Z, Tumbes, Peru
9555 CP6, La Paz, Bol.
9555 BBC, London, Eng.
9555 XETI, Mexico City, Mex.
9560 RTF, Paris, France
9560 Tokyo, Japan
9563 OAX4R, Lima, Peru
9565 ZYK3, Recife, Braz.
9565 Radio Liberty, Ger.
9570 Khabarovsk, U.S.S.R.
9570 Bucharest, Rom.
9575 ZY27, Rio de Jan., Braz.
9575 Taipei, Formosa
9575 RAI, Rome, Italy
9580 VLA9, Melbourne, Aus.
9580 BBC, London, Eng.
9585 ZYR56, Sao Paulo, Braz.
9585 RTF, Paris, France
9588 Peking, China
9590 Djakarta, Indon.

Kcs. Call and Location

9590 Hilversum, Neth.
9590 Bucharest, Rom.
9595 JO23, Tokyo, Japan
9598 CE980, Santiago, Chile
9600 BBC, London, Eng.
9605 Cologne, Ger.
9607 Athens, Greece
9610 VXL9, Perth, Aus.
9610 ZYC8, Rio de Jan., Braz.
9610 Oslo, Norway
9610 OAX8C, Iquitos, Peru
9615 VOA, Tangier, Morocco
9620 ZYR98, Sao Paulo, Braz.
9620 Peking, China
9620 VOA, Tangier, Mor.
9620 Saigon, Vietnam
9625 Brazzaville, Equat. Un.
9625 BBC, London, Eng.
9625 OAX8K, Iquitos, Peru
9630 CRGR1, Luanda, Ang.
9630 VLG9, Melbourne, Aus.
9630 RAI, Rome, Italy
9630 Komsmolsk, U.S.S.R.
9635 ZYR83, Aparecida, Braz.
9635 VOA, Munich, Ger.
9640 BBC, London, Eng.
9640 Cologne, Germany
9640 Accra, Ghana
9640 HKL5, Seoul, Korea
9640 Moscow, U.S.S.R.
9645 TIFJ, San Jose, C.R.
9645 HVJ, Vatican City
9650 BBC, Limassol, Cyprus
9655 Radio Free Europe, Ger.
9660 LRX, Buenos Aires, Arg.
9660 VLG9, Brisbane, Aus.
9660 Radio Liberty, Ger.
9660 Teheran, Iran
9660 Komsmolsk, U.S.S.R.
9665 Moscow, U.S.S.R.
9667 Hargelsa, Somalia
9667 TONA, Guatemala, Guat.
9670 COCC, Havana, Cuba
9670 Prague, Czech.
9675 BBC, London, Eng.
9675 RTF, Paris, France
9675 JOB9, Tokyo, Japan
9675 Warsaw, Poland
9680 VLG9, Melbourne, Aus.
9680 XEQQ, Mexico City, Mex.
9680 VOA, Tangier, Mor.
9680 Parady's, S. Afr.
9685 Algiers, Algeria
9690 LRA, Buenos Aires, Arg.

9690 BBC, London, Eng.
9690 BBC, Singapore
9700 Sofia, Bulgaria
9700 Rabat, Morocco
9705 Kabul, Afghan.
9705 Brussels, Belg.
9705 AIR, Delhi, India
9705 Radio Free Europe, Port.
9710 BBC, London, Eng.
9710 RAI, Rome, It.
9715 Hilversum, Neth.
9715 Radio Free Europe, Ger.
9720 Parady's, S. Afr.
9725 Tel Aviv, Israel
9725 RFE, Port.
9725 BBC, Singapore
9730 Brazzaville, Equat. Un.
9730 Leipzig, E. Ger.
9730 DZH7, Manila, P.I.
9735 Peking, China
9735 BBC, London, Eng.
9735 Cologne, Germany
9735 AIR, Madras, India
9740 VOA, Tangier, Mor.
9742 LRSI, Buenos Aires, Arg.
9745 Brussels, Belg.
9745 HCJB, Quito, Ecua.
9745 Ankara, Turk.
9745 Moscow, U.S.S.R.
9750 BBC, London, Eng.
9750 Radio Free Europe, Port.
9750 Khabarovsk, U.S.S.R.
9755 ZYW23, Goiania, Braz.
9755 RTF, Paris, France
9755 Saigon, Vietnam
9760 BBC, London, Eng.
9762 Hanoi, N. Vietnam
9765 Moscow, U.S.S.R.
9770 Brazzaville, Equat. Un.
9770 BBC, London, Eng.
9775 Moscow, U.S.S.R.
9785 Cairo, U.A.R.
9800 Peking, China
9800 Moscow, U.S.S.R.
9805 Cairo, U.A.R.
9825 BBC, London, Eng.
9833 Budapest, Hung.
9840 Hanoi, N. Vietnam
9850 AIR, Delhi, India
9860 Peking, China
9870 Djakarta, Indon.
9885 Bengazi, Libya
9915 BBC, London, Eng.
9973 Peking, China

10335 Ulan Bator, Mong.
10530 Alma Ata, Kazakh S.S.R.
11290 Peking, China
11570 Moscow, U.S.S.R.
11600 Peking, China
11630 Moscow, U.S.S.R.

Kcs. Call and Location

11650 Peking, China
11665 Cairo, U.A.R.
11675 Peking, China
11675 Karachi, Pak.
11680 BBC, London, Eng.
11685 HVJ, Vat. City
11690 Moscow, U.S.S.R.
11700 RTF, Paris, France
11705 JOA11, Tokyo, Japan
11705 Horby, Sweden
11705 Moscow, U.S.S.R.
11720 VLB11, Melbourne, Aus. †
11710 AIR, Delhi, India
11710 WBOU, New York, N.Y.
11715 VOA, Munich, Ger.
11715 Moscow, U.S.S.R.
11717 Athens, Greece
11720 Brazilia, Brazil
11720 BBC, Limassol, Cyprus
11725 Brazzaville, Equat. Un.
11725 Prague, Czech.
11725 BBC, Singapore
11730 Hilversum, Neth.
11735 Rabat, Morocco
11735 Moscow, U.S.S.R.
11740 VLC11, Melbourne, Aus.
11740 CEI174, Santiago, Chile
11740 Peking, China
11740 VOA, Tangier, Mor.
11745 RFE, Germ.
11750 BBC, London, Eng.
11750 FEN, Tokyo, Japan
11755 RFE, Port.
11755 Hilversum, Neth.
11755 Komsmolsk, U.S.S.R.
11760 VLB11, Melbourne, Aus.
11760 VOA, Munich, Ger.
11760 VOA, Tangier, Mor.
11760 Laurence Marques, Moz.
11760 Hanoi, N. Vietnam
11765 ZYB8, Sao Paulo, Braz.
11765 Berlin, E. Germany
11770 Colombo, Ceylon
11770 BBC, London, Eng.
11775 ZY28, Rio de Jan., Braz.
11775 Moscow, U.S.S.R.
11780 BBC, London, Eng.
11785 Djakarta, Indon.
11785 VOA, Tangier, Morocco
11790 BBC, London, Eng.
11790 VOA, Manila, P.I.
11790 Moscow, U.S.S.R.
11795 ELWA, Monrovia, Lib.
11795 Djakarta, Indon.
11800 BBC, London, Eng.
11802 Warsaw, Poland
11805 RAI, Rome, It.
11805 VOA, Courier, Rhodes
11810 VLB11, Melbourne, Aus. †
11810 RAI, Rome, It.
11810 Amman, Jordan
11810 Bucharest, Rom.
11810 Horby, Sweden
11815 Madrid, Spain
11820 Peking, China
11820 BBC, London, Eng.
11820 XEBR, Hermosillo, Mex.
11825 ELWA, Monrovia, Lib.
11830 RUL, Boston, U.S.A.
11830 Moscow, U.S.S.R.
11835 Algiers, Alg.
11835 VOA, Colombo, Ceylon
11835 CXA19, Montevideo, Urug.
11840 Prague, Czech.
11840 VOA, Tangier, Mor.
11840 Lisbon, Port.
11840 Khabarovsk, U.S.S.R.
11840 Hanoi, N. Vietnam
11845 RTF, Paris, France
11845 Karachi, Pak.
11850 Sofia, Bulg.
11850 AIR, Bombay, India
11850 Oslo, Norway
11855 Brussels, Belg.
11855 Radio Free Europe, Ger.
11855 DZH8, Manila, P.I.
11860 Peking, China
11860 BBC, London, Eng.
11860 Moscow, U.S.S.R.
11865 PRAB, Recife, Braz.
11865 VOA, Tangier, Mor.
11865 HER5, Bern, Switz.
11865 Tunis, Tun.
11870 Moscow, U.S.S.R.
11875 ZYN32, Salvador, Braz.
11875 VOA, Colombo, Ceylon
11875 VOA, Tangier, Mor.
11880 BBC, London, Eng.
11880 XEHH, Mexico City, Mex.
11885 Peking, China
11885 Karachi, Pak.
11885 Radio Free Europe, Ger.
11890 Moscow, U.S.S.R.
11895 Dakar, Mali Fed.
11895 VOA, Tangier, Mor.
11895 VOA, Manila, P.I.
11900 Bucharest, Rumania
11900 CXA10, Montevideo, Ur.
11900 Moscow, U.S.S.R.
11905 RAI, Rome, Italy
11905 WDSI, New York, U.S.A.
11910 BBC, London, Eng.
11910 Budapest, Hung.
11910 Bangkok, Thai.
11915 HCJB, Quito Ecua.
11915 Hilversum, Neth.
11920 RAI, Paris, France

Kcs. Call and Location

11920 DXF2, Manila, P.I.
11920 WLWO, Cincinnati, U.S.A.
11925 ZYB78, Sao Paulo, Braz.
11925 HLK6, Seoul, Korea †
11925 Moscow, U.S.S.R.
11925 Wawsaw, Poland
11930 BBC, London, Eng.
11930 BBC, Singapore
11935 Radio Liberty, Ger.
11940 CEI190, Valparaiso, Chile
11940 JOB11, Tokyo, Japan
11945 Beijing, China
11945 BBC, London, Eng.
11945 Cologne, Germany
11950 Warsaw, Poland
11950 Jidda, Saudi Arab.
11950 Moscow, U.S.S.R.
11955 BBC, London, Eng.
11955 BBC, Singapore
11960 CEI196, Mexico, Ch.
11960 Moscow, U.S.S.R.
11965 Radio Liberty, Ger.
11970 Caracas, Ven.
11972 Brazzaville, Equat. Un.
11975 Peking, China
11975 Moscow, U.S.S.R.
11985 Moscow, U.S.S.R.
11985 ELWA, Monrovia, Lib.
11990 Prague, Czech.
12000 Moscow, U.S.S.R.
12010 Hanoi, Vietnam
12020 AIR, Delhi, India
12020 Moscow, U.S.S.R.
12040 BBC, London, Eng.
12050 Cairo, U.A.R.
12060 BBC, London, Eng.
12020 Hanoi, Vietnam
15030 Peking, China
15060 Peking, China
15070 BBC, London, Eng.
15085 Grenada, Windward Is., BWI

15095 Peking, China
15100 Lisbon, Port.
15100 Moscow, USSR
15105 ZY232, Rio de Jan., Braz.
15105 AIR, Delhi, India
15110 BBC, London, Eng.
15110 Moscow, USSR
15115 HCJB, Quito, Ecuador
15115 Peking, China
15120 Colombo, Ceylon
15120 RAI, Rome, Italy
15120 Warsaw, Poland †
15120 HVJ, Vatican City
15125 ZYN31, Salvador, Brazil
15125 Prague, Czech.
15125 Seoul, Korea
15125 VOA, Manila, P.I.
15125 Lisbon, Portugal
15130 RTF, Paris, France
15130 VOA, Manila, P.I.
15130 KCBR, Delano, Calif.
15130 WBOU, New York, USA
15130 Moscow, USSR
15135 PRB23, Sao Paulo, Braz.
15135 JOB15, Tokyo, Japan
15135 Radio Free Europe, Port.
15140 Peking, China
15140 BBC, London, Eng.
15140 AIR, Delhi, India
15140 Komsmolsk, USSR
15145 ZYK33, Recife, Brazil
15145 Radio Free Europe, Port.
15148 CEI515, Santiago, Chile
15150 Djakarta, Indonesia
15150 Laurence Marques, Moz.
15150 Lisbon, Portugal
15150 Moscow, USSR
15153 OAX4T, Lima, Peru
15153 ZYB9, Sao Paulo, Brazil
15155 Karachi, Pakistan
15155 VOA, Manila, P.I.
15155 WBOU, New York, USA
15155 Moscow, USSR
15155 VLA15, Melbourne, Aus.
15160 RTF, Paris, France
15160 XEWW, Mexico City, Mex.
15160 Ankara, Turkey
15160 Moscow, USSR
15165 ZYN7, Fortaleza, Braz.
15165 Copenhagen, Denmark
15165 Damascus, UAR
15170 Tromsø, Norway
15170 OBX4C, Lima, Peru
15170 Radio Free Europe, Port.
15175 Peking, China
15175 Oslo, Norway
15180 BBC, London, Eng.
15180 AIR, Delhi, India
15180 Moscow, USSR
15185 VOA, Manila, P.I.
15185 Radio Free Europe, Port.
15185 WDSI, New York, USA
15190 Brazzaville, Congo Rep.
15190 Helsinki, Finland †
15190 Komsmolsk, USSR
15190 Moscow, USSR
15195 Prague, Czech.
15195 Radio Free Europe, Ger.
15195 Ankara, Turkey
15200 Parady's, South Africa
15200 WDSI, New York, USA

Kcs. Call and Location

15200 Moscow, USSR
 15205 XESC, Mexico City, Mex.
 15205 WDSI, New York, USA
 15210 VLG15, Melbourne, Aus.
 15210 VOA, Manila, P.I.
 15210 KCBR, Delano, Cal., USA
 15210 Moscow, USSR
 15215 Radio Free Europe, Port.
 15215 VOA, Okinawa, Ryukyu Is.
 15220 Hilversum, Neth. †
 15225 Taipei, Taiwan, China
 15225 Radio Liberty, Germany
 15230 Moscow, USSR
 15230 VLG15, Melbourne, Aus.
 15230 VOA, Colombo, Ceylon
 15230 BBC, London, Eng.
 15235 JOB15, Tokyo, Japan
 15235 VOA, Tangier, Morocco
 15235 Komsomolsk, USSR
 15240 VLA15, Melbourne, Aus.
 15240 Horby, Sweden
 15240 Moscow, USSR
 15240 Belgrade, Yugoslavia
 15245 YZE1, Belem, Brazil
 15250 VOA, Manila, P.I.
 15250 Bucharest, Rumania
 15250 WLO, Cincinnati, USA
 15255 Radio Free Europe, Port.
 15260 FEN, Tokyo, Japan
 15260 BBC, London, Eng.
 15265 Colombo, Ceylon
 15265 Moscow, USSR
 15270 Peking, China
 15270 AIR, Bombay, India
 15270 VOA, Tangier, Morocco
 15270 WBOU, New York, (VOA)
 15270 WDSI, New York, USA
 15275 Cologne, Germany
 15275 Karachi, Pakistan
 15275 VOA, Manila, P.I.
 15275 Warsaw, Poland, †
 15280 ZL4, Wellington, N.Z.
 15280 Moscow, USSR
 15285 Brussels, Belgium
 15285 Prague, Czech.
 15285 AIR, Bombay, India
 15285 WBOU, New York, USA
 15290 LRU, Buenos Aires, Arg.
 15290 Peking, China
 15290 KCBR, Delano, Cal., USA
 15290 WLO, Cincinnati, USA
 15295 Rio de Janeiro, Brazil
 15295 RTF, Paris, France
 15295 VOA, Tangier, Morocco
 15295 Moscow, USSR
 15300 BBC, London, Eng. †
 15300 DZH, Manila, P.I.
 15305 Dacca, Pakistan
 15305 Moscow, USSR
 15310 BBC, London, England
 15310 BBC, Singapore
 15310 KCBR, Delano, Cal., USA
 15315 VLG15, Melbourne, Aus.
 15315 Peking, China
 15315 HEU6, Bern, Switz.
 15315 Moscow, USSR
 15320 VLG15, Melbourne, Aus.
 15320 AIR, Delhi, India
 15320 VOA, Tangier, Morocco
 15325 ZYR22, Salao, Paulo, Braz.
 15325 RAI, Rome, Italy
 15325 JOB15, Tokyo, Japan
 15330 VOA, Munich, Germany
 15330 VOC, Salonika, Greece
 15330 WBOU, New York, USA
 15330 WGOE, Schenectady, USA
 15335 Brussels, Belgium
 15335 ZYU68, Port Alegre, Braz.
 15335 Karachi, Pakistan
 15335 VOA, Manila, P.I.
 15335 Komsomolsk, USSR
 15340 Radio Liberty, Germany
 15340 Moscow, USSR
 15345 LRA, Buenos Aires, Arg.
 15345 Taipei, Taiwan, China
 15345 Athens, Greece

Kcs. Call and Location

15345 Rabat, Morocco
 15350 RTF, Paris, France
 15350 WLO, Cincinnati, USA
 15355 Radio Free Europe, Port.
 15360 BBC, London, England
 15360 Moscow, USSR
 15365 WLO, Cincinnati, Ohio
 15370 ZYC9, Rio de Jan., Braz.
 15370 Radio Liberty, Germany
 15375 BBC, London, Eng.
 15375 Cologne, Germany †
 15380 VOA, Tangier, Morocco
 15380 VOA, Okinawa, Ryukyu Is.
 15380 WRUL, Boston, USA
 15385 DZF3, Manila, P.I.
 15385 CXAG6, Montevideo, Urug.
 15385 Moscow, USSR
 15390 BBC, London, Eng.
 15390 Moscow, USSR
 15395 Radio Liberty, Germany
 15400 RTF, Paris, France
 15400 RAI, Rome, Italy
 15405 Cologne, Germany
 15405 Moscow, USSR
 15407 Paramaribo, Surinam
 15410 Prague, Czech.
 15410 Radio Liberty, Germany
 15410 VOA, Tangier, Morocco
 15415 FRRS, Munich, Germany
 15415 Budapest, Hungary
 15417 Peking, China
 15420 Brazzaville, Congo Rep.
 15417 BBC, London, Eng.
 15420 Madrid, Spain
 15420 Moscow, USSR
 15425 VLG15, Perth, Aus.
 15425 Hilversum, Neth.
 15430 Peking, China
 15430 Cairo, UAR
 15430 Moscow, USSR
 15435 BBC, London, Eng.
 15435 BBC, Singapore
 15440 VOA, Munich, Germany
 15440 Moscow, USSR
 15445 Brazzaville, Congo Rep.
 15445 Hilversum, Neth.
 15447 BBC, London, Eng.
 15450 Komsomolsk, USSR
 15455 Paramaribo, Surinam
 15470 Moscow, USSR
 15475 Cairo, UAR
 15480 Peking, China
 15480 AIR, Delhi, India
 15520 Peking, China
 15555 Peking, China
 15610 Peking, China
 15605 Peking, China
 15675 Peking, China
 15690 Cairo, UAR
 15695 BBC, London, Eng.
 15700 BBC, London, Eng.
 15700 Moscow, USSR
 15705 AIR, Delhi, India
 15705 VOA, Tangier, Morocco
 15710 VLG17, Melbourne, Aus.
 15710 WLO, Cincinnati, USA
 15710 Moscow, USSR
 15715 BBC, London, Eng.
 15715 VOA, Colombo, Ceylon
 15720 Peking, China
 15720 Brazzaville, Congo Rep.
 15720 Radio Liberty, Germany
 15720 Moscow, USSR
 15722 San Jose dos Campos, Braz.
 15725 Radio Free Europe, Port.
 15725 AIR, Delhi, India
 15730 BBC, London, Eng.
 15730 Radio Liberty, Germany
 15735 Radio Free Europe, Port.
 15735 KCBR, Delano, Calif.
 15735 HVJ, Vatican City
 15740 WLO, Cincinnati, USA
 15740 BBC, London, Eng.
 15740 Moscow, USSR
 15745 BBC, London, Eng.
 15745 BBC, London, Eng.

Kcs. Call and Location

17745 Karachi, Pakistan
 17745 VOA, Manila, P.I.
 17747 Peking, China
 17750 WRUL, Boston, USA
 17750 VOA, Tangier, Morocco
 17750 Moscow, USSR
 17755 Prague, Czech.
 17755 BBC, Singapore
 17760 WGOE, Schenectady, USA
 17760 AIR, Delhi, India
 17760 Moscow, USSR
 17765 RTF, Paris, France
 17765 Peking, China
 17770 RAI, Rome, Italy
 17770 Radio Free Europe, Port.
 17770 KCBR, Delano, Cal., USA
 17773 Athens, Greece
 17775 Hilversum, Neth.
 17780 WBOU, New York, USA
 17780 VOA, Manila, P.I.
 17780 Moscow, USSR
 17785 HER7, Berne, Switz.
 17785 AIR, Delhi, India
 17788 Taipei, Formosa, China
 17790 BBC, London, Eng.
 17790 Prague, Czech.
 17790 AIR, Delhi, India
 17795 KGE1, San Fran., USA
 17795 WLO, Cincinnati, USA
 17795 Moscow, USSR
 17795 CRGRZ, Luanda, Angola
 17800 Helsinki, Finland †
 17800 RAI, Rome, Italy
 17800 Warsaw, Poland †
 17805 Radio Free Europe, Port.
 17805 DZ16, Manila, P.I.
 17810 BBC, London, Eng. †
 17810 AIR, Delhi, India
 17810 Hilversum, Neth.
 17810 Moscow, USSR
 17815 Prague, Czech.
 17815 Cologne, Germany
 17815 KCBR, Delano, Calif.
 17815 Moscow, USSR †
 17820 ZL14, Wellington, N.Z.
 17823 Ankara, Turkey
 17825 JOA17, Tokyo, Japan
 17825 Oslo, Norway
 17825 Moscow, USSR
 17830 AIR, Delhi, India
 17830 WDSI, New York, (VOA)
 17830 WLO, Cincinnati, USA
 17835 Radio Free Europe, Port.
 17840 VLB17, Melbourne, Aus.
 17840 Horby, Sweden †
 17840 Moscow, USSR
 17840 HVJ, Vatican City
 17845 Brussels, Belgium
 17845 Cologne, Germany
 17845 WRUL, Boston, USA
 17850 RTF, Paris, France
 17850 Moscow, USSR
 17855 VOA, Tangier, Morocco
 17855 JOA17, Tokyo, Japan
 17855 Radio Free Europe, Port.
 17860 Brussels, Belgium
 17860 BBC, London, Eng.
 17860 Damascus, UAR
 17865 Radio Liberty, Germany
 17870 BBC, London, Eng.
 17870 WLO, Cincinnati, USA
 17875 PRL2, Rio de Jan., Braz.
 17875 Cologne, Germany
 17875 Radio Free Europe, Port.
 17880 Lisbon, Portugal
 17880 Tunis, Tunisia
 17880 Komsomolsk, USSR
 17880 Moscow, USSR
 17885 Radio Free Europe, Port.
 17888 Taipei, Formosa, China
 17890 HCJB, Quito, Ecuador
 17890 BBC, London, Eng.
 17890 HUK42, Seoul, Korea
 17892 Voice of Free Africa
 17895 Lisbon, Port.
 17895 Moscow, USSR

Kcs. Call and Location

17900 Peking, China
 17920 Cairo, UAR
 18080 BBC, London, Eng.
 21450 Prague, Czech.
 21455 VOA, Tangier, Morocco
 21460 KCBR, Delano, Calif.
 21460 WRUL, Boston, USA
 21470 BBC, London, Eng.
 21480 Hilversum, Neth.
 21485 Radio Free Europe, Port.
 21485 WLO, Cincinnati, USA
 21490 BBC, London, Eng.
 21490 Cologne, Germany
 21495 Lisbon, Port.
 21495 DZ16, Manila, P.I.
 21500 Brazzaville, Congo Rep.
 21505 WDSI, New York, USA
 21505 Moscow, USSR
 21510 Brussels, Belgium
 21515 HVJ, Vatican City
 21520 HER8, Berne, Switz.
 21525 Moscow, USSR
 21530 BBC, London, Eng.
 21535 ELWA, Monrovia, Liberia
 21540 VLD21, Melbourne, Aus.
 21540 WBOU, New York, USA
 21550 BBC, London, Eng.
 21550 Moscow, USSR
 21560 RAI, Rome, Italy
 21565 Hilversum, Neth.
 21570 WBOU, New York, (VOA)
 21575 Moscow, USSR
 21580 RTF, Paris, France
 21590 Karachi, Pakistan
 21590 WGOE, Schenectady, USA
 21600 VLG21, Melbourne, Aus.
 21600 Radio Free Europe, Port.
 21605 AIR, Delhi, India
 21605 HE19, Berne, Switz.
 21610 WLO, Cincinnati, (VOA)
 21615 BBC, London, Eng.
 21620 RTF, Paris, France
 21620 AIR, Delhi, India
 21620 JOB21, Tokyo, Japan
 21625 Moscow, USSR
 21630 AIR, Delhi, India
 21640 BBC, London, Eng.
 21650 Cologne, Germany
 21650 AIR, Delhi, India
 21650 WDSI, New York, USA
 21655 VOA, Manila, P.I.
 21660 BBC, London, Eng.
 21665 Radio Free Europe, Port.
 21670 Oslo, Norway
 21675 BBC, London, Eng.
 21680 VLG21, Melbourne, Aus.
 21685 Dacca, Pakistan
 21690 WDSI, New York, USA
 21700 AIR, Delhi, India
 21700 Lisbon, Port.
 21705 VOA, Tangier, Morocco
 21710 BBC, London, Eng.
 21720 Radio Free Europe, Port.
 21730 Brussels, Belgium
 21735 Cologne, Germany
 21735 WLO, Cincinnati, USA
 21740 BBC, London, Eng.
 21740 KCBR, Delano, Cal., USA
 21745 Radio Free Europe, Port.
 25610 Hilversum, Neth.
 25630 KCBR, Delano, Cal., USA
 25650 BBC, London, Eng.
 25670 BBC, London, Eng.
 25670 BBC, London, Eng.
 25735 VLY25, Melbourne, Aus.
 25750 BBC, London, Eng.
 25800 Paradys, S. Afr.
 25840 BBC, London, Eng.
 25840 VOA, Tangier, Morocco
 25900 Oslo, Norway
 25920 BBC, London, Eng.
 26040 WBOU, New York, USA
 25950 WBOU, New York, USA
 26080 BBC, London, Eng.

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Kc. C.L. Location

5970 CBNX St. John's, Nfld.
 5970 CKNA Montreal, Que.*
 5990 CHAY Montreal, Que.*
 6005 CFXC Montreal, Que.*
 6010 CJCX Sydney, N.S.
 6030 CFVP Calgary, Alta.
 6060 CKRZ Montreal, Que.*

Kc. C.L. Location

6070 CFRX Toronto, Ont.
 6080 CKFX Vancouver, B.C.
 6090 CBFW Montreal, Que.
 6090 CKOB Montreal, Que.*
 6130 CBNX Halifax, N.S.
 6160 CBUX Vancouver, B.C.*
 6160 CHAC Montreal, Que.*
 9520 CBRF Montreal, Que.*
 9585 CKLP Montreal, Que.*
 9610 CBFX Montreal, Que.*
 9610 CHLS Montreal, Que.*
 9630 CBFO Montreal, Que.

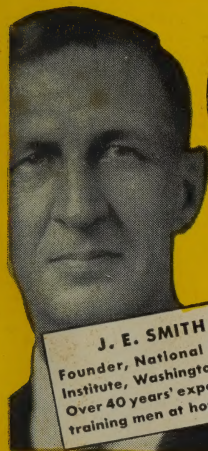
Kc. C.L. Location

9630 CKLO Montreal, Que.*
 9710 CHLR Montreal, Que.*
 9740 CHFO Montreal, Que.*
 11705 CBFY Montreal, Que.*
 11705 CKXA Montreal, Que.*
 11710 CBFL Montreal, Que.*
 11720 CHXK Montreal, Que.*
 11760 CBFA Montreal, Que.*
 11760 CKRA Montreal, Que.*
 11900 CKEX Montreal, Que.*
 11945 CKEX Montreal, Que.*
 15090 CKLX Montreal, Que.*

Kc. C.L. Location

15105 CKUS Montreal, Que.*
 15190 CBFX Montreal, Que.*
 15190 CKXZ Montreal, Que.*
 15255 CKSR Montreal, Que.*
 15275 CKBR Montreal, Que.*
 15320 CKKS Montreal, Que.*
 17710 CHSE Montreal, Que.*
 17735 CHRX Montreal, Que.*
 17820 CKNC Montreal, Que.*
 17865 CHYS Montreal, Que.*
 21600 CKRP Montreal, Que.*
 21710 CHLA Montreal, Que.*

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 KCCU**

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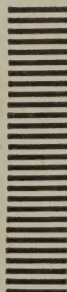
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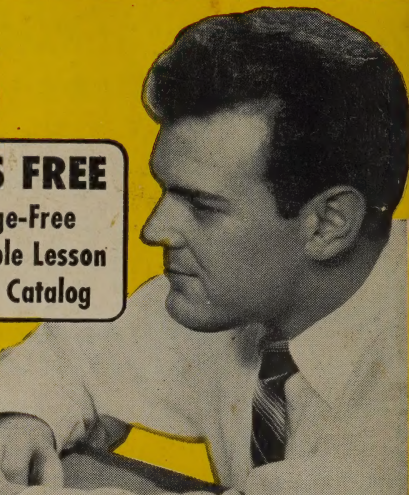
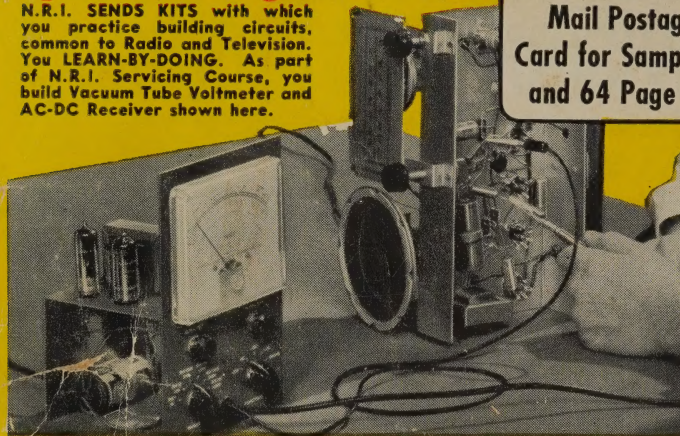
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